DIVISION 2
TECHNICAL SPECIFICATIONS

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APPENDIX A

Construction Safety and Phasing Plan Narrative (CSPP)

Referenced Sections of:
State of Connecticut Department of Transportation
Standard Specifications for Roads, Bridges, Facilities and Incidental Construction - Form 819

Part 3 – Sitework

Item P-101 Preparation/Removal of Existing Pavements

DESCRIPTION

101-1 This item shall consist of preparation of existing pavement surfaces, surface treatments, removal of existing pavement, and other miscellaneous items. The work shall be accomplished in accordance with these specifications and the applicable plans.

EQUIPMENT AND MATERIALS

101-2 All equipment and materials shall be specified here and in the following paragraphs or approved by the Resident Project Representative (RPR). The equipment shall not cause damage to the pavement to remain in place.

CONSTRUCTION

101-3.1 Removal of existing pavement.

The Contractor's removal operation shall be controlled to not damage adjacent pavement structure, and base material, cables, utility ducts, pipelines, or drainage structures which are to remain under the pavement.

a. Concrete pavement removal. Full depth saw cuts shall be made perpendicular to the slab surface. The Contractor shall saw through the full depth of the slab including any dowels at the joint, removing the pavement and installing new dowels as shown on the plans and per the specifications. Where the perimeter of the removal limits is not located on the joint and there are no dowels present, the perimeter shall be saw cut the full depth of the pavement. The pavement inside the saw cut shall be removed by methods which will not cause distress in the pavement which is to remain in place. Concrete slabs that are damaged by under breaking shall be repaired or removed and replaced as directed by the RPR.

The edge of existing concrete pavement against which new pavement abuts shall be protected from damage at all times. Spall and underbreak repair shall be in accordance with the plans. Any underlaying material that is to remain in place, shall be recompacted and/or replaced as shown on the plans. Adjacent areas damaged during repair shall be repaired or replaced at the Contractor's expense.

b. Asphalt pavement removal. Asphalt pavement to be removed shall be cut to the full depth of the asphalt pavement around the perimeter of the area to be removed.

c. Repair or removal of Base, Subbase, and/or Subgrade. All failed material including surface, base course, subbase course, and subgrade shall be removed and repaired as shown on the plans or as directed by the RPR. Materials and methods of construction shall comply with the applicable sections of these specifications. Any damage caused by Contractor's removal process shall be repaired at the Contractor's expense.

101-3.2 Preparation of joints and cracks prior to overlay/surface treatment. Not used.

101-3.3 Removal of Foreign Substances/contaminates prior to Seal-Coat or Remarking. Removal of foreign substances/contaminates from existing pavement that will affect the bond of the new treatment

shall consist of removal of rubber, fuel spills, oil, crack sealer, at least 90% of paint, and other foreign substances from the surface of the pavement. Areas that require removal are designated on the plans and as directed by the RPR in the field during construction.

High-pressure water, heater scarifier (asphaltic concrete only), cold milling, or rotary grinding may be used. Removal methods used shall not cause major damage to the pavement, or to any structure or utility within or adjacent to the work area. Major damage is defined as changing the properties of the pavement, removal of asphalt causing the aggregate to ravel, or removing pavement over 1/8 inch (3 mm) deep. If it is deemed by the RPR that damage to the existing pavement is caused by operational error, such as permitting the application method to dwell in one location for too long, the Contractor shall repair the damaged area without compensation and as directed by the RPR.

Removal of foreign substances shall not proceed until approved by the RPR. Water used for high-pressure water equipment shall be provided by the Contractor at the Contractor's expense. No material shall be deposited on the pavement shoulders. All wastes shall be disposed of in areas indicated in this specification or shown on the plans.

101-3.4 Concrete spall or failed asphaltic concrete pavement repair. Not used.

101-3.6. Preparation of asphalt pavement surfaces prior to surface treatment. Not used.

101-3.7 Maintenance. The Contractor shall perform all maintenance work necessary to keep the pavement in a satisfactory condition until the full section is complete and accepted by the RPR. The surface shall be kept clean and free from foreign material. The pavement shall be properly drained at all times. If cleaning is necessary or if the pavement becomes disturbed, any work repairs necessary shall be performed at the Contractor’s expense.

101-3.8 Preparation of Joints in Rigid Pavement prior to resealing. Prior to application of sealant material, clean and dry the joints of all scale, dirt, dust, old sealant, curing compound, moisture and other foreign matter. The Contractor shall demonstrate, in the presence of the RPR, that the method used cleans the joint and does not damage the joint..

101-3.8.1 Removal of Existing Joint Sealant. All existing joint sealants will be removed by plowing or use of hand tools. Any remaining sealant and or debris will be removed by use of wire brushes or other tools as necessary. Resaw joints removing no more than 1/16 inch (2 mm) from each joint face. Immediately after sawing, flush out joint with water and other tools as necessary to completely remove the slurry.

101-3.8.2 Cleaning prior to sealing. Immediately before sealing, joints shall be cleaned by removing any remaining laitance and other foreign material. Allow sufficient time to dry out joints prior to sealing. Joint surfaces will be surface-dry prior to installation of sealant.

101-3.8.3 Joint sealant. Joint material and installation will be in accordance with Item P-605.

101-3.9 Preparation of Cracks in Flexible Pavement prior to sealing. Not used.

101-3.9.1 Preparation of Crack. Widen crack with router or random crack saw by removing a minimum of 1/16 inch (2 mm) from each side of crack. Immediately before sealing, cracks will be blown out with a hot air lance combined with oil and water-free compressed air.

101-3.9.2 Removal of Existing Crack Sealant. Existing sealants will be removed by routing or random crack saw. Following routing or sawing any remaining debris will be removed by use of a hot lance combined with oil and water-free compressed air.

101-3.9.3 Crack Sealant. Crack sealant material and installation will be in accordance with Item P-605.

101-3.9.4 Removal of Pipe and other Buried Structures.

a. Removal of Existing Pipe Material. Remove the types of pipe as indicated on the plans. The pipe material shall be legally disposed of off-site in a timely manner following removal. Trenches shall

be backfilled with material equal to or better in quality than adjacent embankment. Trenches under paved areas must be compacted to 95% of ASTM D1557**.**

b. Removal of Inlets/Manholes. Where indicated on the plans or as directed by the RPR, inlets and/or manholes shall be removed and legally disposed of off-site in a timely fashion after removal. Excavations after removal shall be backfilled with material equal or better in quality than adjacent embankment. When under paved areas must be compacted to 95% of ASTM D1557, when outside of paved areas must be compacted to 95% of ASTM D698.

METHOD OF MEASUREMENT

101-4.1 No separate measurement for payment will be made. The work covered by this section shall be considered as a subsidiary obligation of the Contractor and covered under the other contract items.

BASIS OF PAYMENT

101-5.1 The work covered by this section shall be considered as a subsidiary obligation of the Contractor covered under the other contract items. No separate payment will be made.

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

Advisory Circulars (AC)

AC 150/5380-6	Guidelines and Procedures for Maintenance of Airport Pavements.

ASTM International (ASTM)

ASTM D6690	Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements

END OF ITEM P-101

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Item P-151 Clearing and Grubbing

DESCRIPTION

151-1.1 This item shall consist of clearing or clearing and grubbing, including the disposal of materials, for all areas within the limits designated on the plans or as required by the Resident Project Representative (RPR).

a. Clearing shall consist of the cutting and removal of all trees, stumps, brush, logs, hedges, the removal of fences and other loose or projecting material from the designated areas. The grubbing of stumps and roots will not be required.

b. Clearing and grubbing shall consist of clearing the surface of the ground of the designated areas of all trees, stumps, down timber, logs, snags, brush, undergrowth, hedges, heavy growth of grass or weeds, fences, structures, debris, and rubbish of any nature, natural obstructions or such material which in the opinion of the RPR is unsuitable for the foundation of strips, pavements, or other required structures, including the grubbing of stumps, roots, matted roots, foundations, and the disposal from the project of all spoil materials resulting from clearing and grubbing.

c. Tree Removal. Tree Removal shall consist of the cutting and removal of isolated single trees or isolated groups of trees, and the grubbing of stumps and roots. The removal of all the trees of this classification shall be in accordance with the requirements for the particular area being cleared.

CONSTRUCTION METHODS

151-2.1 General. The areas denoted on the plans to be cleared and grubbed shall be staked on the ground by the Contractor as indicated on the plans.

The removal of existing structures and utilities required to permit orderly progress of work shall be accomplished by local agencies, unless otherwise shown on the plans. Whenever a telephone pole, pipeline, conduit, sewer, roadway, or other utility is encountered and must be removed or relocated, the Contractor shall advise the RPR who will notify the proper local authority or owner to secure prompt action.

151-2.1.1 Disposal. All materials removed by clearing or by clearing and grubbing shall be disposed of outside the Airport's limits at the Contractor's responsibility, except when otherwise directed by the RPR. As far as practicable, waste concrete and masonry shall be placed on slopes of embankments or channels. When embankments are constructed of such material, this material shall be placed in accordance with requirements for formation of embankments. Any broken concrete or masonry that cannot be used in construction and all other materials not considered suitable for use elsewhere, shall be disposed of by the Contractor. In no case, shall any discarded materials be left in windrows or piles adjacent to or within the airport limits. The manner and location of disposal of materials shall be subject to the approval of the RPR and shall not create an unsightly or objectionable view. When the Contractor is required to locate a disposal area outside the airport property limits, the Contractor shall obtain and file with the RPR permission in writing from the property owner for the use of private property for this purpose.

151-2.1.2 Blasting. Blasting shall not be allowed.

151-2.2 Clearing. The Contractor shall clear the staked or indicated area of all materials as indicated on the plans. Trees unavoidably falling outside the specified clearing limits must be cut up, removed, and

disposed of in a satisfactory manner. To minimize damage to trees that are to be left standing, trees shall be felled toward the center of the area being cleared. The Contractor shall preserve and protect from injury all trees not to be removed. The trees, stumps, and brush shall be cut flush with the original ground surface. The grubbing of stumps and roots will not be required.

Fences shall be removed and disposed of as directed by the RPR. Fence wire shall be neatly rolled and the wire and posts stored on the airport if they are to be used again, or stored at a location designated by the RPR if the fence is to remain the property of a local owner or authority.

151-2.3 Clearing and grubbing. In areas designated to be cleared and grubbed, all stumps, roots, buried logs, brush, grass, and other unsatisfactory materials as indicated on the plans, shall be removed, except where embankments exceeding 3-1/2 feet (105 cm) in depth will be constructed outside of paved areas. For embankments constructed outside of paved areas, all unsatisfactory materials shall be removed, but sound trees, stumps, and brush can be cut off flush with the original ground and allowed to remain. Tap roots and other projections over 1-1/2 inches (38 mm) in diameter shall be grubbed out to a depth of at least 18 inches (0.5 m) below the finished subgrade or slope elevation.

Any buildings and miscellaneous structures that are shown on the plans to be removed shall be demolished or removed, and all materials shall be disposed of by removal from the site. The cost of removal is incidental to this item. The remaining or existing foundations, wells, cesspools, and like structures shall be destroyed by breaking down the materials of which the foundations, wells, cesspools, etc., are built to a depth at least 2 feet (60 cm) below the existing surrounding ground. Any broken concrete, blocks, or other objectionable material that cannot be used in backfill shall be removed and disposed of at the Contractor's expense. The holes or openings shall be backfilled with acceptable material and properly compacted.

All holes in embankment areas remaining after the grubbing operation shall have the sides of the holes flattened to facilitate filling with acceptable material and compacting as required in Item P-152. The same procedure shall be applied to all holes remaining after grubbing in areas where the depth of holes exceeds the depth of the proposed excavation.

METHOD OF MEASUREMENT

151-3.1 Clearing and Grubbing will be measured based on the percentage of work completed as determined by the RPR.

BASIS OF PAYMENT

151-4.1 Clearing and Grubbing will be paid for as a percentage of the contract lump sum based on the work completed as determined by the RPR.

Payment will be made under:

Item P-151	Clearing and Grubbing

END OF ITEM P-151

Item P-152 Excavation, Subgrade, and Embankment

DESCRIPTION

152-1.1 This item covers excavation, disposal, placement, and compaction of all materials within the limits of the work required to construct safety areas, runways, taxiways, aprons, and intermediate areas as well as other areas for drainage, building construction, parking, or other purposes in accordance with these specifications and in conformity to the dimensions and typical sections shown on the plans.

152-1.2 Classification. All material excavated shall be classified as defined below:

a. Unclassified excavation. Unclassified excavation shall consist of the excavation and disposal of all material, regardless of its nature which is not otherwise classified and paid for under one of the following items.

b. Rock excavation. Rock excavation shall include all solid rock in ledges, in bedded deposits, in unstratified masses, and conglomerate deposits which are so firmly cemented they cannot be removed without blasting or using rippers. All boulders containing a volume of more than 1/2 cubic yard (0.4 m^3) will be classified as "rock excavation."

152-1.3 Unsuitable excavation. Unsuitable material shall be disposed off Airport property. Materials containing vegetable or organic matter, such as muck, peat, organic silt, or sod shall be considered unsuitable for use in embankment construction. Material suitable for topsoil may be used on the embankment slope when approved by the RPR.

CONSTRUCTION METHODS

152-2.1 General. Before beginning excavation, grading, and embankment operations in any area, the area shall be cleared or cleared and grubbed in accordance with Item P-151.

The suitability of material to be placed in embankments shall be subject to approval by the RPR. All unsuitable material shall be disposed off Airport property.

When the Contractor's excavating operations encounter artifacts of historical or archaeological significance, the operations shall be temporarily discontinued and the RPR notified per Section 70, paragraph 70-20. At the direction of the RPR, the Contractor shall excavate the site in such a manner as to preserve the artifacts encountered and allow for their removal. Such excavation will be paid for as extra work.

Areas outside the limits of the pavement areas where the top layer of soil has become compacted by hauling or other Contractor activities shall be scarified and disked to a depth of 4 inches (100 mm), to loosen and pulverize the soil. Stones or rock fragments larger than 4 inches (100 mm) in their greatest dimension will not be permitted in the top 6 inches (150 mm) of the subgrade.

If it is necessary to interrupt existing surface drainage, sewers or under-drainage, conduits, utilities, or similar underground structures, the Contractor shall be responsible for and shall take all necessary precautions to preserve them or provide temporary services. When such facilities are encountered, the Contractor shall notify the RPR, who shall arrange for their removal if necessary. The Contractor, at their own expense, shall satisfactorily repair or pay the cost of all damage to such facilities or structures that may result from any of the Contractor's operations during the period of the contract.

a. Blasting. Blasting shall not be allowed.

152-2.2 Excavation. No excavation shall be started until the work has been staked out by the Contractor and the RPR has obtained from the Contractor, the survey notes of the elevations and measurements of the ground surface. The Contractor and RPR shall agree that the original ground lines shown on the original topographic mapping are accurate, or agree to any adjustments made to the original ground lines.

All areas to be excavated shall be stripped of vegetation and topsoil. Topsoil shall be stockpiled for future use in areas designated on the plans or by the RPR. All suitable excavated material shall be used in the formation of embankment, subgrade, or other purposes as shown on the plans. All unsuitable material shall be disposed off Airport property.

The grade shall be maintained so that the surface is well drained at all times.

When the volume of the excavation exceeds that required to construct the embankments to the grades as indicated on the plans, the excess shall be used to grade the areas of ultimate development or disposed as directed by the RPR. When the volume of excavation is not sufficient for constructing the embankments to the grades indicated, the deficiency shall be obtained from borrow areas.

a. Selective grading. When selective grading is indicated on the plans, the more suitable material designated by the RPR shall be used in constructing the embankment or in capping the pavement subgrade. If, at the time of excavation, it is not possible to place this material in its final location, it shall be stockpiled in approved areas until it can be placed. The more suitable material shall then be placed and compacted as specified. Selective grading shall be considered incidental to the work involved. The cost of stockpiling and placing the material shall be included in the various pay items of work involved.

b. Undercutting. Rock, shale, hardpan, loose rock, boulders, or other material unsatisfactory for safety areas, subgrades, roads, shoulders, or any areas intended for turf shall be excavated to a minimum depth of 12 inches (300 mm) below the subgrade or to the depth specified by the RPR. Muck, peat, matted roots, or other yielding material, unsatisfactory for subgrade foundation, shall be removed to the depth specified. Unsuitable materials shall be disposed off the airport. The cost is incidental to this item. This excavated material shall be paid for at the contract unit price per cubic yard (cubic meter) for unclassified excavation. The excavated area shall be backfilled with suitable material obtained from the grading operations or borrow areas and compacted to specified densities. The necessary backfill will constitute a part of the embankment. Where rock cuts are made, backfill with select material. Any pockets created in the rock surface shall be drained in accordance with the details shown on the plans. Undercutting will be paid as unclassified excavation.

c. Over-break. Over-break, including slides, is that portion of any material displaced or loosened beyond the finished work as planned or authorized by the RPR. All over-break shall be graded or removed by the Contractor and disposed of as directed by the RPR. The RPR shall determine if the displacement of such material was unavoidable and their own decision shall be final. Payment will not be made for the removal and disposal of over-break that the RPR determines as avoidable. Unavoidable over-break will be classified as “Unclassified Excavation.”

d. Removal of utilities. The removal of existing structures and utilities required to permit the orderly progress of work will be accomplished by the Contractor as indicated on the plans. All existing foundations shall be excavated at least 2 feet (60 cm) below the top of subgrade or as indicated on the plans, and the material disposed of as directed by the RPR. All foundations thus excavated shall be backfilled with suitable material and compacted as specified for embankment or as shown on the plans.

152-2.3 Borrow excavation. There are no borrow sources within the boundaries of the airport property. The Contractor shall locate and obtain borrow sources, subject to the approval of the RPR. The Contractor shall notify the RPR at least 15 days prior to beginning the excavation so necessary measurements and tests can be made by the RPR. All borrow pits shall be opened to expose the various strata of acceptable

material to allow obtaining a uniform product. Borrow areas shall be drained and left in a neat, presentable condition with all slopes dressed uniformly. Borrow areas shall not create a hazardous wildlife attractant.

152-2.4 Drainage excavation. Drainage excavation shall consist of excavating drainage ditches including intercepting, inlet, or outlet ditches; or other types as shown on the plans. The work shall be performed in sequence with the other construction. Ditches shall be constructed prior to starting adjacent excavation operations. All satisfactory material shall be placed in embankment fills; unsuitable material shall be placed in designated waste areas or as directed by the RPR. All necessary work shall be performed true to final line, elevation, and cross-section. The Contractor shall maintain ditches constructed on the project to the required cross-section and shall keep them free of debris or obstructions until the project is accepted.

152-2.5 Preparation of cut areas or areas where existing pavement has been removed. In those areas on which a subbase or base course is to be placed, the top 12 inches (300 mm)of subgrade shall be compacted to not less than 95 % of maximum density for non-cohesive soils, and 95% of maximum density for cohesive soils as determined by ASTM D1557. As used in this specification, "non-cohesive" shall mean those soils having a plasticity index (PI) of less than 3 as determined by ASTM D4318.

152-2.6 Preparation of embankment area. All sod and vegetative matter shall be removed from the surface upon which the embankment is to be placed. The cleared surface shall be broken up by plowing or scarifying to a minimum depth of 6 inches (150 mm) and shall then be compacted per paragraph 152-2.10.

Sloped surfaces steeper than one (1) vertical to four (4) horizontal shall be plowed, stepped, benched, or broken up so that the fill material will bond with the existing material. When the subgrade is part fill and part excavation or natural ground, the excavated or natural ground portion shall be scarified to a depth of 12 inches (300 mm) and compacted as specified for the adjacent fill.

No direct payment shall be made for the work performed under this section. The necessary clearing and grubbing and the quantity of excavation removed will be paid for under the respective items of work.

152-2.7 Control Strip. The first half-day of construction of subgrade and/or embankment shall be considered as a control strip for the Contractor to demonstrate, in the presence of the RPR, that the materials, equipment, and construction processes meet the requirements of this specification. The sequence and manner of rolling necessary to obtain specified density requirements shall be determined. The maximum compacted thickness may be increased to a maximum of 12 inches (300 mm) upon the Contractor's demonstration that approved equipment and operations will uniformly compact the lift to the specified density. The RPR must witness this demonstration and approve the lift thickness prior to full production.

Control strips that do not meet specification requirements shall be reworked, re-compacted, or removed and replaced at the Contractor's expense. Full operations shall not begin until the control strip has been accepted by the RPR. The Contractor shall use the same equipment, materials, and construction methods for the remainder of construction, unless adjustments made by the Contractor are approved in advance by the RPR.

152-2.8 Formation of embankments. The material shall be constructed in lifts as established in the control strip, but not less than 6 inches (150 mm) nor more than 12 inches (300 mm) of compacted thickness.

When more than one lift is required to establish the layer thickness shown on the plans, the construction procedure described here shall apply to each lift. No lift shall be covered by subsequent lifts until tests verify that compaction requirements have been met. The Contractor shall rework, re-compact and retest any material placed which does not meet the specifications.

The lifts shall be placed, to produce a soil structure as shown on the typical cross-section or as directed by the RPR. Materials such as brush, hedge, roots, stumps, grass and other organic matter, shall not be incorporated or buried in the embankment.

Earthwork operations shall be suspended at any time when satisfactory results cannot be obtained due to rain, freezing, or other unsatisfactory weather conditions in the field. Frozen material shall not be placed in the embankment nor shall embankment be placed upon frozen material. Material shall not be placed on surfaces that are muddy, frozen, or contain frost. The Contractor shall drag, blade, or slope the embankment to provide surface drainage at all times.

The material in each lift shall be within ±2% of optimum moisture content before rolling to obtain the prescribed compaction. The material shall be moistened or aerated as necessary to achieve a uniform moisture content throughout the lift. Natural drying may be accelerated by blending in dry material or manipulation alone to increase the rate of evaporation.

The Contractor shall make the necessary corrections and adjustments in methods, materials or moisture content to achieve the specified embankment density.

The Contractor will take samples of excavated materials which will be used in embankment for testing and develop a Moisture-Density Relations of Soils Report (Proctor) in accordance with ASTM D1557. A new Proctor shall be developed for each soil type based on visual classification.

Density tests will be taken by the Contractor for every 100 square yards of compacted embankment for each lift which is required to be compacted, no less than 3 per lift, or other appropriate frequencies as determined by the RPR.

If the material has greater than 30% retained on the 3/4-inch (19.0 mm) sieve, follow AASHTO T-180 Annex Correction of maximum dry density and optimum moisture for oversized particles.

Rolling operations shall be continued until the embankment is compacted to not less than **95**% of maximum density for non-cohesive soils, and 95% of maximum density for cohesive soils as determined by ASTM D1557. Under all areas to be paved, the embankments shall be compacted to a depth of 12 inches and to a density of not less than **95%** percent of the maximum density as determined by ASTM D1557. As used in this specification, "non-cohesive" shall mean those soils having a plasticity index (PI) of less than 3 as determined by ASTM D4318.

On all areas outside of the pavement areas, no compaction will be required on the top 4 inches (100 mm) which shall be prepared for a seedbed in accordance with Item T-901.

The in-place field density shall be determined in accordance with ASTM D1556. The Contractor's laboratory shall perform all density tests in the RPR's presence and provide the test results upon completion to the RPR for acceptance. If the specified density is not attained, the area represented by the test or as designated by the RPR shall be reworked and/or re-compacted and additional random tests made. This procedure shall be followed until the specified density is reached.

Compaction areas shall be kept separate, and no lift shall be covered by another lift until the proper density is obtained.

During construction of the embankment, the Contractor shall route all construction equipment evenly over the entire width of the embankment as each lift is placed. Lift placement shall begin in the deepest portion of the embankment fill. As placement progresses, the lifts shall be constructed approximately parallel to the finished pavement grade line.

When rock, concrete pavement, asphalt pavement, and other embankment material are excavated at approximately the same time as the subgrade, the material shall be incorporated into the outer portion of the embankment and the subgrade material shall be incorporated under the future paved areas. Stones, fragmentary rock, and recycled pavement larger than 4 inches (100 mm) in their greatest dimensions will

not be allowed in the top 12 inches (300 mm) of the subgrade. Rockfill shall be brought up in lifts as specified or as directed by the RPR and the finer material shall be used to fill the voids forming a dense, compact mass. Rock, cement concrete pavement, asphalt pavement, and other embankment material shall not be disposed of except at places and in the manner designated on the plans or by the RPR.

When the excavated material consists predominantly of rock fragments of such size that the material cannot be placed in lifts of the prescribed thickness without crushing, pulverizing or further breaking down the pieces, such material may be placed in the embankment as directed in lifts not exceeding 2 feet (60 cm) in thickness. Each lift shall be leveled and smoothed with suitable equipment by distribution of spalls and finer fragments of rock. The lift shall not be constructed above an elevation 4 feet (1.2 m) below the finished subgrade.

There will be no separate measurement of payment for compacted embankment. All costs incidental to placing in lifts, compacting, discing, watering, mixing, sloping, and other operations necessary for construction of embankments will be included in the contract price for excavation, borrow, or other items.

152-2.9 Proof rolling. The purpose of proof rolling the subgrade is to identify any weak areas in the subgrade and not for compaction of the subgrade. Before start of embankment and after compaction is completed, the subgrade area shall be proof rolled with a 20 ton (18.1 metric ton) Tandem axle Dual Wheel Dump Truck loaded to the legal limit with tires inflated to 100 psi (0.689 MPa) in the presence of the RPR. Apply a minimum of 75% coverage, or as specified by the RPR, under pavement areas. A coverage is defined as the application of one tire print over the designated area. Soft areas of subgrade that deflect more than 1 inch (25 mm) or show permanent deformation greater than 1 inch (25 mm) shall be removed and replaced with suitable material or reworked to conform to the moisture content and compaction requirements in accordance with these specifications. Removal and replacement of soft areas is incidental to this item.

152-2.10 Compaction requirements. The subgrade under areas to be paved shall be compacted to a depth of 12 inches (300 mm) and to a density of not less than **95** percent of the maximum dry density as determined by ASTM D1557. The subgrade in areas outside the limits of the pavement areas shall be compacted to a depth of 12 inches (300 mm) and to a density of not less than 95 percent of the maximum density as determined by ASTM D698.

The material to be compacted shall be within ±2% of optimum moisture content before being rolled to obtain the prescribed compaction (except for expansive soils). When the material has greater than 30 percent retained on the ¾ inch (19.0 mm) sieve, follow the methods in ASTM D1557procedures in AASHTO T180 Annex for correction of maximum dry density and optimum moisture for oversized particles. Tests for moisture content and compaction will be taken at a minimum of 100 S.Y. of subgrade. All quality assurance testing shall be done by the Contractor's laboratory in the presence of the RPR, and density test results shall be furnished upon completion to the RPR for acceptance determination.

The in-place field density shall be determined in accordance with ASTM D1556. The machine shall be calibrated in accordance with ASTM D6938 within 12 months prior to its use on this contract. The gage shall be field standardized daily.

Maximum density refers to maximum dry density at optimum moisture content unless otherwise specified.

If the specified density is not attained, the entire lot shall be reworked and/or re-compacted and additional random tests made. This procedure shall be followed until the specified density is reached.

All cut-and-fill slopes shall be uniformly dressed to the slope, cross-section, and alignment shown on the plans or as directed by the RPR and the finished subgrade shall be maintained.

152-2.11 Finishing and protection of subgrade. Finishing and protection of the subgrade is incidental to this item. Grading and compacting of the subgrade shall be performed so that it will drain readily. All low

areas, holes or depressions in the subgrade shall be brought to grade. Scarifying, blading, rolling and other methods shall be performed to provide a thoroughly compacted subgrade shaped to the lines and grades shown on the plans. All ruts or rough places that develop in the completed subgrade shall be graded, re-compacted, and retested. The Contractor shall protect the subgrade from damage and limit hauling over the finished subgrade to only traffic essential for construction purposes.

The Contractor shall maintain the completed course in satisfactory condition throughout placement of subsequent layers. No subbase, base, or surface course shall be placed on the subgrade until the subgrade has been accepted by the RPR.

152-2.12 Haul. All hauling will be considered a necessary and incidental part of the work. The Contractor shall include the cost in the contract unit price for the pay of items of work involved. No payment will be made separately or directly for hauling on any part of the work.

The Contractor's equipment shall not cause damage to any excavated surface, compacted lift or to the subgrade as a result of hauling operations. Any damage caused as a result of the Contractor's hauling operations shall be repaired at the Contractor's expense.

The Contractor shall be responsible for providing, maintaining and removing any haul roads or routes within or outside of the work area, and shall return the affected areas to their former condition, unless otherwise authorized in writing by the Owner. No separate payment will be made for any work or materials associated with providing, maintaining and removing haul roads or routes.

152-2.13 Surface Tolerances. In those areas on which a subbase or base course is to be placed, the surface shall be tested for smoothness and accuracy of grade and crown. Any portion lacking the required smoothness or failing in accuracy of grade or crown shall be scarified to a depth of at least 3 inches (75 mm), reshaped and re-compacted to grade until the required smoothness and accuracy are obtained and approved by the RPR. The Contractor shall perform all final smoothness and grade checks in the presence of the RPR. Any deviation in surface tolerances shall be corrected by the Contractor at the Contractor’s expense.

a. **Smoothness.** The finished surface shall not vary more than +/- ½ inch (12 mm) when tested with a 12-foot (3.7-m) straightedge applied parallel with and at right angles to the centerline. The straightedge shall be moved continuously forward at half the length of the 12-foot (3.7-m) straightedge for the full length of each line on a 50-foot (15-m) grid.

b. **Grade.** The grade and crown shall be measured on a 50-foot (15-m) grid and shall be within +/- 0.05 feet (15 mm) of the specified grade.

On safety areas, turfed areas and other designated areas within the grading limits where no subbase or base is to placed, grade shall not vary more than 0.10 feet (30 mm) from specified grade. Any deviation in excess of this amount shall be corrected by loosening, adding or removing materials, and reshaping.

152-2.14 Topsoil. When topsoil is specified or required as shown on the plans or under Item T-905, it shall be salvaged from stripping or other grading operations. The topsoil shall meet the requirements of Item T-905. If, at the time of excavation or stripping, the topsoil cannot be placed in its final section of finished construction, the material shall be stockpiled at approved locations. Stockpiles shall be located as shown on the plans and the approved CSPP, and shall not be placed on areas that subsequently will require any excavation or embankment fill. If, in the judgment of the RPR, it is practical to place the salvaged topsoil at the time of excavation or stripping, the material shall be placed in its final position without stockpiling or further re-handling.

Upon completion of grading operations, stockpiled topsoil shall be handled and placed as shown on the plans and as required in Item T-905. Topsoil shall be paid for as provided in Item T-905. No direct payment will be made for topsoil under Item P-152.

METHOD OF MEASUREMENT

152-3.1 Excavation, Subgrade, and Embankment will be measured based on the percentage of work completed as determined by the RPR.

152-3.2 Rock excavation will be measured as the number of cubic yards (cubic meters) measured in its original position. Measurement shall not include the quantity of materials excavated without authorization beyond normal slope lines, or the quantity of material used for purposes other than those directed.

BASIS OF PAYMENT

152-4.1 Excavation, Subgrade, and Embankment will be measured based on the percentage of work completed as determined by the RPR. This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-152-3.1	Excavation, Subgrade, and Embankment
Item P-152-3.2	Rock Excavation - per cubic yard (cubic meter)

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO T-180	Standard Method of Test for Moisture-Density Relations of Soils Using a 4.54-kg (10-lb) Rammer and a 457-mm (18-in.) Drop

ASTM International (ASTM)

ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3))
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method
ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2700 kN-m/m^3))
ASTM D6938	Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth)

Advisory Circulars (AC)

AC 150/5370-2	Operational Safety on Airports During Construction Software

Software

FAARFIELD – FAA Rigid and Flexible Iterative Elastic Layered Design

U.S. Department of Transportation

FAA RD-76-66	Design and Construction of Airport Pavements on Expansive Soils

END OF ITEM P-152

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Part 4 – Base Courses

Item P-209 Crushed Aggregate Base Course

Crushed Aggregate Base Course shall be specified under the following Connecticut Department of Transportation based specifications:

31 08 00 – Earthwork

31 23 16 – Excavation, Backfill & Subgrade Preparation for Pavement

Appendix A

Referenced Sections of

Connecticut Department of Transportation

Standard Specifications for Roads, Bridges, Facilities and Incidental Construction - Form 819

METHOD OF MEASUREMENT

209-3.1 Crushed Aggregate Base Course will be measured based on the percentage of work completed as determined by the RPR.

BASIS OF PAYMENT

209-4.1 Crushed Aggregate Base Course will be measured based on the percentage of work completed as determined by the RPR. This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-209	Crushed Aggregate Base Course

END OF ITEM P-209

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SECTION 31 08 00 - EARTHWORK

PART 1 - GENERAL

1.1 DESCRIPTION

A. General and Supplementary Conditions and Division 1 Specification Sections apply to this Section.

B. General: Perform earthwork in accordance with the Contract Documents.

C. Work Included: Work of this Section includes all labor, materials, equipment, and services necessary to complete the excavation, subgrade preparation, filling and grading as shown on the Contract Documents including, but not limited to the following:

1. Earth excavation as indicated on the Contract Documents, or to a lower elevation to achieve required bearing capacity, if directed by the Owner's Engineer.

2. Legally disposing offsite excavated materials in accordance with the project specifications.

3. Dewatering as required to complete the work.

4. Subgrade preparation.

5. Protection and monitoring of adjacent structures, utilities, and pavements.

6. Other labor and materials as may be reasonably inferred to be required to make the work under this Section complete.

1.2 RELATED SECTIONS

A. Section 31 23 16 – Excavation, Backfill and Subgrade Preparation for Pavement

B. Item C-102 - Temporary Air and Water Pollution, Soil Erosion, and Siltation Control

C. Item P-101 - Preparation/Removal of Existing Pavements

D. Item P-151 - Clearing and Grubbing

E. Item P-152 - Excavation, Subgrade, and Embankment

1.3 REFERENCES

A. General: All work and materials under this section shall conform to the latest revision of the following standard specifications, where not otherwise required by the Contract Documents.

American Society for Testing and Materials (ASTM) – latest edition.

1. C 136 Test for Sieve Analysis of Fine and Coarse Aggregates.

2. D 422 Method for Particle Size Analysis of Soils.

3. D 1140 Test for Amount of Material in Soils Finer than No. 200 (75 mm) Sieve.

4. D 1556 Test for Density and Unit Weight of Soil in Place by the Sand-Cone Method.

5. D 1557 Test for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3) (Modified Proctor).

6. D 2216 Laboratory Determination of Moisture content of Soil and Rock Mass.

7. D 2487 Classification of Soils for Engineering Purposes (Unified Soil Classification System).

8. D 6938 Tests Methods for In-Place Density and Water Content of Soil and Soil- Aggregate in Place by Nuclear Methods (Shallow Depth).

9. D 4253 Test Method of Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.

10. D 4254 Test Methods for Minimum Index Density and Unit Weight of Soils and Calculations of Relative Density.

11. D 4318 Test for Plastic Limit, Liquid Limit, and Plasticity Index of Soils.

12. D 1883 Test Method for California Bearing ratio (CBR) of Laboratory Compacted Soils.

B. American Association of State Highway and Transportation Officials (AASHTO) – Latest edition: T 88 Mechanical Analysis of Soils.

C. 2018 Connecticut State Building Code (IBC 2015).

D. Connecticut Department of Energy and Environmental Protection (CTDEEP) *Guidelines for Soil Erosion and Sediment Control*.

E. Connecticut Department of Transportation (CTDOT) *Standard Specifications for Roads, Bridges and Incidental Construction*, latest edition.

F. Federal Aviation Administration AC 150/5370-10H – *Standard Specifications for Construction of Airports*.

G. Applicable local, state, and federal rules, ordinances, laws and regulations.

1.4 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by the Owner's Engineer. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.

2. Bulk Excavation: Excavation more than 10 feet.

3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by the Owner's Engineer. Unauthorized excavation, as well as remedial work directed by the Owner's Engineer, shall be without additional compensation.

F. Fill: Soil materials used to raise existing grades.

G. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock-excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:

1. Equipment for Footing, Trench, and Pit Excavation: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch-maximum-width, short-tip-radius rock bucket; rated at not less than 138-hpflywheel power with bucket-curling force of not less than 28,700 lbf and stick-crowd force of not less than 18,400 lbf with extra-long reach boom.

2. Equipment for Bulk Excavation: Late model, track-mounted loader; rated at not less than 230-hpflywheel power and developing a minimum of 47,992-lbfbreakout force with a general-purpose bare bucket.

H. Structures: Building footings and foundation walls, retaining walls, equipment pads, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Aggregate layer placed between the subgrade and base course.

J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase.

K. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings limits.

1.5 SUBMITTALS

A. Within ten days after award of the contract submit a schedule detailing the sequence, and time of completion of all phases of work under this section.

B. At least two weeks in advance of imported fill use submit the following laboratory test data and a 25-pound soil sample to the Owner's Engineer for review and approval:

1. Submit test reports on borrow material as follows:

a. Moisture and Density (modified proctor) Relationship: ASTM D1557.

b. Mechanical Analysis: AASHTO T-88.

c. Moisture content in accordance with ASTM D 2216.

d. Relative Density: ASTM D4254.

e. California Bearing Ratio (CBR): ASTM D1883, if utilized as subgrade material beneath paved areas.

f. Plasticity Index: ASTM 4318.

g. Test for Sieve Analysis of Fine and Coarse Aggregates: C 136.

2. Include data for all samples indicating the exact location and methods of transportation and placement of all materials.

3. Submit documentation for each of the imported material certifying them as "Clean Fill" in accordance with Part 2, Section 2.1, Article A of this specification.

C. Submit the name of each material supplier and specific type and source of each material. Any change in source or soil type throughout the job requires approval of the Owner.

D. Samples: Submit a 12 inch by 12 inch sample of geosynthetic fabrics.

E. Temporary Excavation Support Shop Drawings:

1. Submit detailed shop drawings and calculations, to be reviewed by the Owner's Engineer, of earthwork procedures and sequences including temporary excavation support systems, if required.

2. The temporary excavation support system drawings shall bear the signature and seal of a Professional Engineer registered in the State of Connecticut.

F. Dewatering: Prepare dewatering shop drawings. The dewatering plan shall be designed by the Contractor's Engineer.

G. Pre-Construction Conditions Survey: Perform a pre-construction conditions survey of all immediate offsite adjacent structures and surrounding critical site features, the results of which will be made available to the Owner upon completion of the survey (include digital copies of photographs). The survey shall consist of photographic and video documentation and shall include a plan detailing the limits of the work and any observed damage.

H. Monitoring: Submit a plan showing location of proposed vertical and horizontal control points. Submit survey readings of the control points within 24 hours of the survey. Plan and survey readings shall be signed and sealed by a Land Surveyor registered in the State of Connecticut.

I. Certification for Examination of Site and Records: Before proceeding with the work, submit a signed certification in an acceptable form stating that careful examination has been made of the site, existing structures, records of utility lines, test boring records, test pit records, and subsurface exploration reports by the Owner's Engineer, and the Contract Documents.

J. Submit approvals and permits to the Owner a minimum of 15 days prior to commencement of construction.

1.6 ENVIRONMENTAL CONSIDERATIONS

A. Install erosion control measures in the sequence shown on the Contract Documents or as directed by the Engineer or regulatory agencies to protect adjacent properties and water resources from erosion and sediment damage.

B. Soil disposal shall be in accordance with all applicable local, state, and federal rules, ordinances, laws and regulations.

C. Take all necessary measures and provide equipment and/or materials to minimize dust from rising and blowing across the site and into adjacent natural systems, and also to control surface water throughout the operation so that it does not run onto paved ways without being filtered. In addition, control all dust created by construction operation and movement of construction vehicles, both on site and on paved ways. Comply with the 2002 Connecticut Sediment and Erosion Control Guidelines.

1.7 PROJECT CONDITIONS

A. Carefully examine the nature and location of the work; the conformation of the ground, the nature of the subsurface conditions; the location of the groundwater table; the

character, quality and quantity of the materials to be encountered; the character of the equipment and facilities needed preliminary to and during the execution of the work; the conditions of adjacent structures and utilities and all other matters which can in any way effect the work.

B. Visit the site and be familiar with the existing conditions of adjoining utilities and structures.

C. Deduce subsurface conditions which may affect the methods or cost of construction of the work hereunder and agree that there will be no claims for damages or compensations, except as are provided under the agreement, should conditions during the progress of the work be different from those as calculated and/or anticipated. Additional borings and other exploratory operations may be performed if needed following the Owner's approval. No change in the Contract Sum will be authorized for such additional exploration.

D. Investigate the conditions of public thoroughfares and roads as to availability, clearances, loads, limits, restrictions, and other limitations affecting transportation to, ingress and egress of the site of the work. Conform to all local, state and federal rules, ordinances, laws and regulations concerning the transportation of materials to and from and at the job site and shall secure in advance such permits as may be required.

1.8 PRE-CONSTRUCTION CONDITION SURVEY

Perform a pre-construction conditions survey of the structures and critical site features immediately adjacent to the work area, prior to the start of work and shall include the results of this survey with their shop drawings submittal to the Owner before commencement of work.

1.9 PROTECTION

A. Protection of Adjacent Structures, Utilities and Pavements

1. Prior to commencement of any work, consult the records for existing utilities, and note all conditions and limitations, which might affect the work required under this section.

2. Become acquainted with the existence and location of all surface and subsurface structures and utilities within the project area. Do not damage any of those that are to remain and leave them accessible.

3. Execute the work so that no damage or injury will occur to existing public and adjoining or adjacent structures, streets, paving, sewers, gas, water, electric or any other pipes. Should any damage or injury caused by anyone in employ, or by the work under this Contract occur, make good such damage at no additional expense to the Owner and assume all responsibility for such injury.

4. Provide barricades and warning lights, barriers, etc., to prevent accidents, to avoid all necessary hazards and protect the public, the work, and property at all times, including weekends and holidays.

5. The above shall also include the protection of all existing utilities to remain in use within and adjacent to the area affected by the work of this project.

6. Monuments, benchmarks and other reference features bounding this project, shall be protected. Should these be disturbed in any manner have them replaced at own expense.

7. Excavation work shall be restricted to hours indicated in the Contract Documents.

8. The Contractor's Surveyor shall install control points on the adjacent structures and pavement for vertical and horizontal monitoring (to the nearest 0.005 ft.). Control points shall be monitored weekly during construction.

B. Protection of Excavation Bottoms

1. Facilities and materials needed to prevent earth at the bottom of excavation from becoming frozen or unsuitable shall be furnished.

2. The excavation shall not be carried to final grades during freezing weather without providing complete protection against freezing of the subgrades as specified hereinafter. Complete protection against freezing shall also be provided if freezing weather sets in after completion of the excavation to final subgrade. This protection shall include adequate heating and coverage of the area to maintain temperatures above freezing until backfilled.

3. Where excavations have been brought to the bottom elevations called for on the Contract Documents, and the bottom of these excavations become unsuitable in the opinion of the Owner's Engineer because of inadequate protection, these excavations shall be carried to lower depths sufficient to provide stable bearing as determined by the Owner's Engineer.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Imported fill shall be Clean Fill as defined below and shall consist of a relatively well-graded mixture of sand and gravel. Suitable imported fill should be free of organics, clay, excessive silt, other deleterious or compressible materials, cinders, frozen material, trash, masonry, rubble, and other deleterious materials with 3-inch maximum size aggregate and not more than 12 percent passing the No. 200 sieve. In addition, any approved imported fill should be free of all hazardous substances. Grain-size distribution and modified Proctor compaction tests (ASTM D1557) should be made on representative samples of the imported fill proposed.

B. Clean Fill is defined in the Solid Waste Regulations found at Section 22a-209-1 of the Regulations of Connecticut State Agencies (RCSA). Clean Fill means (1) natural soil (2) rock, brick, ceramics, concrete, and asphalt paving fragments which are virtually inert and pose neither a pollution threat to ground or surface waters nor a fire hazard and (3) polluted soil as defined in Subdivision (45) of Subsection (a) of Section 22a-133k-1 of the RCSA which soil has been treated to reduce the concentration of pollutants to levels which do not exceed the applicable Pollutant Mobility Criteria and Direct Exposure Criteria established in Sections 22a-133k-1 through 22a-133k-3 of the RCSA and which soil is reused in accordance with Subdivision (3) of Subsection (h) of Section 22a-133k-2 of the RCSA. Documentation, including, but not limited to laboratory analytical reports and source location, shall be provided for review and approval by Owner prior to the importation of Clean Fill.

C. 3/4-Inch Crushed Stone: Crushed stone shall be a quarry product or washed gravel stone obtained from offsite sources for use as detailed on the drawings. Crushed stone shall consist of durable crushed rock or gravel stone essentially free of silt, clay, loam or other deleterious materials and shall conform to the following graduation requirements for the nominal size indicated.

SQUARE MESH SIEVES	PERCENT FINER BY WEIGHT
Pass 1 Inch	100
Pass 3/4 Inch	90 – 100
Pass 1/2 Inch	20 – 55
Pass 3/8 Inch	0 – 15
Pass No. 4	0 – 5

D. Bedding Material:

1. Type "A" Bedding: Well-graded gravels and gravel sand mixtures free of debris, waste, frozen materials, and organics within the following limits:

SQUARE MESH SIEVES	PERCENT FINER BY WEIGHT
Pass 1-1/2 Inch	100
Pass No. 4	10 - 50
Pass No. 200	0 - 5

2. Type "B" Bedding: Sand or sandy soil free of debris, waste, frozen materials, and organics within the following limits:

SQUARE MESH SIEVES	PERCENT FINER BY WEIGHT
Pass 3/8 Inch	100
Pass No. 4	100 - 95
Pass No. 200	0 - 10

E. Granular Fill (Also Termed Structural Fill): Granular fill shall be obtained from offsite borrow sources for use as fill and backfill below and interior to building areas except

where other materials are specified or detailed, and as details on the drawings. Granular fill shall consist of non-plastic naturally or artificially graded mixture of sound coarse and fine aggregates free of debris, waste, frozen materials and organics and conforming to the following gradation:

SQUARE MESH SIEVES	PERCENT FINER BY WEIGHT
Pass 3-1/2 Inch	100
Pass 1-1/2 Inch	55 – 100
Pass 1/4 Inch	25 – 60
Pass No. 10	15 – 45
Pass No. 40	5 – 25
Pass No. 100	0 – 10
Pass No. 200	0 – 5

F. Flowable / Excavatable Fill: Mixture of cement, sand, water and admixtures to produce a flowable / excavatable fill with a compressive strength at 28 days of 100 psi to 150 psi.

G. Crushed Stone/Crushed Gravel/Drainage Aggregate: Free draining natural clean, crushed durable stone free of deleterious materials and conforming to the gradation requirements commercially known as ¾-inch clean crushed durable stone (AASHTO No. 57 or approved alternative). Recycled concrete aggregate shall not be acceptable.

H. Processed Aggregate: Coarse and fine aggregates mixed to conform to the gradation requirements of CTDOT Form 819, M.05.01.

I. Compacted Subbase: Coarse and fine aggregates mixed to conform to the gradation requirements of CTDOT Form 819, M.02.02.

J. The use of recycled concrete aggregate (RCA) is not permitted as a drainage backfill material against structures.

K. Filter Fabric: Basis of Design: Mirafi 140N manufactured by TC Mirafi or approved equivalent woven geotextile filter fabric where specified.

L. Stabilization Fabric: Basis of Design: Mirafi 600X manufactured by TC Mirafi or approved equivalent geotextile fabric where specified.

M. The use of mole rock is not permitted.

PART 3 - EXECUTION

3.1 CODES, PERMITS AND REGULATIONS

A. Comply with all applicable local, state and federal rules, ordinances, laws and regulations.

B. Obtain and pay for all permits and licenses required to execute and complete the work.

C. In case of conflict between regulations and specifications, comply with the most stringent applicable codes, regulations or specifications.

3.2 PUMPING AND DEWATERING

A. Provide adequate pumps, or other equipment, appurtenances, power, drains, materials and labor necessary to dewater and maintain a dry excavation as required for the completion of all work throughout the period of the contract.

B. Manage stormwater runoff to limit impact on construction.

C. The dewatering system shall be installed and operated in such a manner as to avoid the movement of fines or loss of ground from below the bearing level and shall not influence the stability of surrounding areas. The facilities needed to eliminate loss of ground shall be included.

D. Do not conduct water to privately owned properties.

E. Any pumped groundwater which will require offsite disposal shall comply with all local, state, and federal rules, ordinances, laws and regulations.

3.3 EXCAVATION

A. General

1. Excavation work shall include removal and disposal of all materials encountered regardless of the nature of the materials and shall be understood to include but not limited to rock, boulders, earth, hardpan, fill, structures, utilities, pavements, curbs, piping and debris, and others.

2. Excavation shall extend to the dimensions and elevations required for the installation of the work described herein and as indicated on the Contract Documents. Excavation lines shall provide sufficient clearance for the proper execution of all work, including allowances for form work, shoring and inspection.

3. Materials that in the opinion of the Owner's Engineer are not suitable for fill and any surplus earth shall be removed from the site and disposed off-site in accordance with the project specifications.

4. Existing utility lines to be retained that are shown on the Contract Documents or the locations of which are made known prior to excavation operations, shall be

protected from damage during excavation and backfilling, and if damaged, shall be repaired at no additional cost to the Owner.

B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not disintegrate or excavate rock until it has been classified by the Owner's Engineer and cross-sectioned by the Owner's registered land surveyor. The Contract Sum will be adjusted for rock excavation according to contract provisions for changes in the work. Changes in the Contract Time may be authorized for rock excavation

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; and soil, boulders, and other materials not classified as rock or unauthorized excavation.

a. Intermittent drilling; ram hammering; or ripping of material not classified as rock excavation is earth excavation.

2. Rock excavation includes removal and disposal of rock and includes replacement with approved materials.

a. Uncover and expose all rock surfaces to be removed.

b. Notify Owner in writing before rock removal proceeds.

c. The Owner will engage a registered land surveyor to cross section the top of rock and determine the quantity of rock for payment. Measurements for payment will be based on in place cubic yards of rock removed to paylines, as defined:

i. For Walls with Footings: The measurements will be taken horizontally parallel to and 12 inches outside of the edges of the concrete footings and vertically 12 inches below bottom of footing elevation as indicated in the Contract Documents.

ii. For Walls without Footings: The measurements will be taken horizontally parallel to and 12 inches outside of the edges of the concrete limits and vertically 12 inches below bottom of concrete elevation as indicated in the Contract Documents.

iii. For Walks, Pavements and Equipment Pads: The measurement will be taken vertically 12 inches below slab subgrade elevation as indicated in the Contract Documents.

iv. For Utility Trenches: The measurement will be taken vertically 6 inches below bottom of pipe and horizontally 24 inches wider than the nominal diameter of pipe/conduit as indicated in the Contract Documents.

v. For Structures: The measurement will be taken horizontally 24 inches greater in both length and width or diameter than the actual exterior

dimensions of the structures and vertically 12 inches below bottom elevation of structure as indicated in the Contract Documents.

d. No payment will be made for overblasted rock and/or shattered layers below paylimits, associated removal and replacement with suitable fill material.

C. Excavation for Foundations

1. Foundation subgrades shall be inspected and approved by the Owner's Engineer before proceeding with the construction of foundations.

2. Subgrade of foundations shall be level and free of loose soil, debris, standing water and frost prior to acceptance for placing concrete. The Owner's Engineer shall inspect and approve the foundation subgrade to verify that the subgrade material is adequate to provide the recommended allowable bearing pressure.

3. Unauthorized Excavation: When suitable bearing material is encountered at subgrade elevations indicated on the Contract Documents and excavation is made to a greater depth, the excavation shall be backfilled with structural fill and compacted in accordance with the project specifications at no additional cost to the Owner.

D. Subgrade Preparation

1. Natural undisturbed material shall be graded and compacted to attain a uniform surface. These areas shall be determined by the Owner's Engineer.

2. Prior to constructing foundations, slabs, utilities, utility structures, fields, and paved/hardscape areas, the subgrade shall be proof rolled in the presence of the Owner's Engineer for the following conditions:

a. Subgrades shall be proof rolled with a minimum of six passes of a 10-ton roller where accessible or other method approved by the Owner's Engineer. For all other subgrades, proof rolling shall be accomplished with a minimum of six passes of a 5-ton walk-behind vibratory roller.

b. Foundation elements shall not be placed until the subgrade is approved by the Owner's Engineer. All structural fill footing subgrades shall be tested to confirm the top lift of the footing subgrade is compacted to the project specified requirement for structural fill material.

c. Soft Areas during Compaction: If any areas show pumping, noticeable weaving, or which are otherwise unsatisfactory, undercut material to competent material within the limits and extent suggested by the Owner's Engineer. These areas shall be replaced with structural fill, compacted to 95% of maximum dry density by ASTM D1557. The appropriate water content at the time of compaction should be plus or minus 2 percentage points of optimum moisture content as determined by the laboratory compaction test aforementioned, unless otherwise directed by the Owner's Engineer. If structural fill is utilized, the excavation shall be oversized to include the zone of influence (1H:1V) beneath and beyond the footing and footing level.

d. Subgrades should be excavated level and if any cobbles or boulders are encountered at the footing subgrade level such that a relatively level subgrade is not achieved, the cobbles or boulders should be removed and replaced with compacted structural fill or compacted crushed stone.

e. Consideration should be given to protecting the natural sand and gravel subgrades after excavation utilizing either clean, crushed, durable, compacted ¾ inch stone, or a mud mat.

E. Excavation for General Grading:

1. Excavations made below the elevations shown or specified, unless authorized by Change Order, shall be backfilled and compacted in accordance with the project specifications at no additional cost to the Owner.

F. Trench Excavation:

1. Unless otherwise shown or specified, make trenches for piping and utilities not less than 16 inches or more than 24 inches wider than the outside width of the piping or utilities. Accurately grade bottoms of trenches with bell holes scooped out to provide uniform bearing and support of pipe and utilities on undisturbed soil throughout its entire length, except where other means of supporting pipe are indicated.

2. Trenches for underground conduit and piping, where necessary, shall be excavated to the required depth and bell holes shall be provided where necessary to insure uniform bearing. Trench excavation lines shall provide sufficient clearance for the proper execution of underground mechanical work.

3. Trenches shall be by open cut from the surface. No tunneling will be allowed except by consent of the Owner's Engineer. Irregularities at bottom of trench, or where excavation is below required depth, shall be refilled to required grade with compacted granular fill.

4. Pipe trenches shall be excavated and minimum cover shall be provided to required depths as per the Connecticut State Building Code. Excavated materials adjacent to trench as directed shall be neatly banked.

5. Where trenches are in wet or soft ground that in the opinion of the Owner's Engineer is unsuitable for supporting the piping, concrete cradles or approved equivalent shall be installed.

6. Where necessary, the sides of trenches and excavations shall be supported by adequate bracing and conform with applicable OSHA regulations to insure proper construction and safety of the workers. Assume responsibility for damages to property or injury to persons resulting from improper quality, strength, placing, maintaining and removing of same.

7. Prior to utility installation, soil subgrades in the utility trenches should be proof rolled as specified herein. Pipe bedding should be placed and compacted in accordance with the pipe manufacturer's requirements or as indicated in the Contract Documents, whichever is more stringent.

8. Immediately after piping has been installed, tested, inspected, and accepted, piping shall be filled around with special care to solidly fill voids without causing injury to piping. Up to two feet above the pipe's crown, the utility excavation shall be backfilled using structural fill placed in 4-inch thick loose lifts. For the remainder of trench backfill, the excavation shall be backfilled using structural fill placed in 12-inch thick loose lifts. Each layer shall be compacted as specified herein before placing the next layer. Backfill shall be in such a manner so as to prevent future settlement.

3.4 FILLING AND COMPACTING

A. General

1. Do not commence filling and backfilling operations until construction below finish grade has been approved, underground utilities and mechanical items inspected and tested, forms removed, waterproofing or damproofing and other improvements installed, trash and debris removed, and temporary and permanent bracing installed.

2. Do not commence backfilling, filling and grading until existing subgrade has been compacted to 95% of the material's maximum dry density as determined by the Modified Proctor Compaction Test (ASTM D1557).

3. Fill all excavations and do all filling and grading necessary to bring the surfaces to the level required.

4. No fill material shall be placed on areas where free water is standing, or frozen subsoil area, or on surface which have not been approved for fill placement by the Owner's Engineer.

5. Do not backfill against concrete elements until the concrete has obtained its specified compressive strength.

6. Take particular care when rolling over areas where trenches or other excavations have been made and backfilled.

B. Grading

1. Prior to placing fill or backfill in any area, grading is to be performed as required to provide for drainage. Ditching or filling around the area will be performed to intercept or divert all surface water. Within the area the ground which fill is to be placed will be graded so as to provide for unobstructed drainage from every point to a sump or other disposal point.

2. On completion of grading as specified above, closely examine to determine whether excessive wetness, springs, or other seepage of water can be observed at any point. If such conditions exist, positive drainage in suitable form, such as french drains or tilling, must be provided before placement of fill is undertaken.

C. Placement and Compaction of Controlled Fill and Backfill

1. Placement

a. Begin fill and backfilling in the lowest section of the area. Spread material evenly by mechanical equipment or by manual means above the approved compacted subgrade in lifts not exceeding 10 to 12 inches for material compacted by heavy machinery and 4 inches for material compacted by hand tamping. Build layers as horizontally as practical to prevent thickness of lift from exceeding that specified but provide with sufficient longitudinal and transverse slope to provide for runoff of surface water from every point.

b. Moisture Control: Moisture-density curve for the fill shall be utilized as a guide in controlling moisture to achieve the required degree of compaction. If, in the opinion of the Owner's Engineer, fill material becomes too wet for the required compaction, the fill shall be dried by a method approved by the Owner's Engineer prior to commencing or continuing compaction operations. Likewise, if, in the opinion of the Owner's Engineer, the fill material becomes too dry for the required compaction, the fill shall be moistened by a method approved by the Owner's Engineer prior to commencing or continuing compaction operations. The water content at the time of compaction should be within 2% points of the optimum water content.

2. Compaction: Compact each lift to 95% of the maximum dry laboratory density by ASTM D1557. Perform field density tests in accordance with ASTM D6938. Complete field density tests at the intervals indicated below:

i. Backfill Lifts: Every 2,500 square feet but not less than 3 tests per lift. Each successive lift shall not be placed or compacted until the previous lift is approved by the Owner's Engineer.

ii. Trench Backfill and Base: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests

3. Drainage During Fill Operation: At all times, maintain and operate proper and adequate surface and subsurface drainage to the satisfaction of the Owner's Engineer in order to keep the construction site dry and in such condition that placement and compaction of fill may proceed unhindered by saturation of the area.

4. Frost: Do not place fill materials when either the fill materials or the previous lift (or subgrade) on which it is placed is frozen. In the event that any fill which has already been placed on the surface shall become frozen, it shall be scarified and re-compacted, or removed, to the approval of the Owner's Engineer before the next lift is placed. Remove or re-compact any soft spots resulting from frost to the satisfaction of the Owner's Engineer before new fill is placed.

3.5 MAINTENANCE

A. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.

B. Repair and re-establish grades in settled, eroded, and rutted areas to specified tolerances.

C. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density prior to further construction.

D. Settling: Where settling is measurable or observable at excavated areas, remove surface (pavement, lawn, or other finish), add backfill material, compact, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent work and eliminate evidence of restoration to greatest extent possible.

3.6 QUALITY CONTROL AND INSPECTION

A. The Owner's Engineer will review all laboratory test results and submitted reports specified in this Section.

B. The Owner's Engineer will interpret the tests, state in each report whether or not the test specimens and results comply with all requirements of the Contract Documents and note any deviations.

C. The Owner's Engineer will identify when and where samples are to be obtained. Collect samples and forward them to the Owner's Testing Laboratory. Testing Laboratory will submit the following laboratory test reports to the Owner's Engineer:

1. Laboratory results conducted on each type of borrow and fill material:

a. Gradation Analysis ASTM D422.

b. Atterberg limits ASTM D 4318.

c. Modified Moisture-density curve determination ASTM D1557.

2. Owner's Engineer will determine the conformance of materials to be used for fills.

D. Field Inspection:

1. Proof Rolling: Proof rolling where required shall be inspected by Owner's Engineer.

2. Paved Area and Building Slab Subgrades: Owner's Engineer shall inspect subgrades for paved areas and building slabs. No pavement or slab shall be constructed unless the subgrade approved by the Owner's Engineer.

3. Backfilling and Compaction: Backfilling and compaction below paved areas, building slabs, behind the foundation walls, and any other backfilling and compaction work shall be inspected by the Owner's Engineer. No fill shall be placed unless the previous lift is approved by the Owner's Engineer.

E. Cooperate with the Owner's Engineer in the performance of the required tests.

3.7 DISPOSAL OF EXCAVATED MATERIALS

Legally dispose the excavated material at an off-site disposal facility, in accordance with all local, state, and federal rules, ordinances, laws and regulations.

3.8 ERRORS IN DEPTH

In the event that any part of the excavation is carried, through error, more than 0.1 feet beyond the depth and the dimensions indicated on the drawings or called for in the specifications, other than additional excavation as directed by the Owner's Engineer, the associated transportation and disposal costs for the over excavated material shall not be an additional cost to the Owner. Furnish and install gravel or stone with which to fill to the required level at no additional cost to the Owner. Where established bottoms as shown on drawings have not been maintained or have been disturbed by operations under this contract, they shall be cleaned out and back filled at no additional cost to the Owner.

END OF SECTION 31 08 00

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SECTION 31 23 16 – EXCAVATION, BACKFILL & SUBGRADE PREPARATION FOR PAVEMENT

PART 1 – GENERAL

1.1 RELATED SECTIONS AND DOCUMENTS

A. General and Supplementary Conditions and Division 1 Specification Sections apply to this Section.

B. Section 31 08 00 – Earthwork

C. Section 32 12 16 – Asphaltic Concrete Paving

D. Item C-102 - Temporary Air and Water Pollution, Soil Erosion, and Siltation Control

E. Item P-101 - Preparation/Removal of Existing Pavements

F. Item P-151 - Clearing and Grubbing

G. Item P-152 - Excavation, Subgrade, and Embankment

1.2 SCOPE OF WORK

A. Excavation and backfilling to line, grade and configuration as shown in the Contract Documents for proposed asphaltic concrete pavement and Portland cement concrete pavement.

B. Removal of unsuitable material beneath proposed paved areas.

C. Compacting fill materials in acceptable manner as specified herein.

1.3 REFERENCE STANDARDS

A. American Society for Testing and Materials (ASTM) - latest edition

1. D 422 Method for Particle Size Analysis of Soils

2. D 1557 Test for Moisture-Density Relations of Soils Using 10-lb (4.5 Kg) Hammer and 18-inch (457 mm) Drop (Modified Proctor)

3. D 2216 Laboratory Determination of Moisture content of Soil

4. D 2487 Classification of Soils for Engineering Purposes

5. D 2922 Tests for Density of Soil and Soil- Aggregate in Place by Nuclear Methods (Shallow Depth)

6. D 3017 Test for Moisture Content of Soil and Soil-Aggregate in Place by Nuclear Methods (Shallow Depth)
7. D 4318 Test for Plastic Limit, Liquid Limit, and Plasticity Index of Soils

B. American Association of State Highway and Transportation Officials (AASHTO) - latest edition: T 88 Mechanical Analysis of Soils.

C. Federal Aviation Administration AC 150/5370-10H – Standard Specifications for Construction of Airports.

D. All applicable OSHA Regulations

1.4 QUALITY ASSURANCE

The Owner's Engineer may perform quality assurance testing on filling operations and subgrade preparation as specified in Section 31 08 00 and described herein. This inspection will not relieve any requirements to complete the work in accordance with the Contract Documents.

1.5 SUBMITTALS

Submit gradation and certification of aggregate material that is to be used for review at least one week prior to use on-site.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Fill material from off-site source as specified in Section 31 08 00 of these specifications and approved by the Owner's Engineer.

2.2 EQUIPMENT

A. Off-site materials shall be transported to project using well maintained and operating vehicles. Once on-site, transporting vehicles shall at no time endanger improvements by rutting, overloading, or pumping.

B. Excavation is to be performed using capable, well maintained equipment and methods acceptable to the Owner and the Contract Document requirements and schedule.

C. Compaction shall be performed utilizing a 5-ton static drum weight, vibratory, smooth drum roller or other equipment approved by the Owner's Engineer.

D. Smaller compaction equipment, together with thinner lifts may be required at areas of limited access or maneuverability. In such a case, the compaction equipment shall be a double drum walk-behind roller and shall be subject to the Owner's Engineer approval.

PART 3 - EXECUTION

3.1 PREPARATION

A. Identify lines, elevations, and grades necessary to construct pavements, curb, sidewalk, and roadways as shown on Contract Documents.

B. Protect benchmarks, property corners, and other survey monuments from damage or displacement. If a marker needs to be removed it shall be referenced by the Contractor's Surveyor and replaced, as necessary, by same.

C. Locate and identify site utilities that have previously been installed and protect them from damage.

D. Locate and identify existing utilities that are to remain and protect them from damage.

E. Overexcavate and properly prepare areas of subgrade that are not capable of supporting proposed systems if directed by Owner's Engineer. These areas shall be stabilized with aggregate material placed and compacted as specified.

3.2 EXCAVATION

A. Excavate roadways and pavement areas to line and grade as shown on the Contract Documents.

B. Areas of existing curb islands, sidewalks and existing pavement failure shall be excavated to competent soil to the satisfaction of the Owner's Engineer. Excavation of soft soils will be required in both fill and overlay areas to the satisfaction of the Owner's Engineer.

C. Perform excavation using capable, well maintained equipment and methods acceptable to the Owner's Engineer and other authorities have jurisdiction.

D. Where existing grades are above proposed subgrade elevation, excavate materials in the pavement areas to the subgrade elevations necessary based on the finished pavement lines and grades as shown in the Contract Documents being careful not to overexcavate beyond the elevations needed. Replacement of fill in areas over excavated without approval of the Owner's Engineer shall be replaced as compacted fill in accordance with these specifications at no additional cost to the Owner.

E. Excavated on-site soils shall be disposed of off-site in accordance with the project specifications and all applicable local, state and federal regulations.

F. Unsuitable material, such as wood and any other deleterious materials, shall be legally disposed of off-site at no additional cost to the Owner.

3.3 SUBGRADE PREPARATION

A. Excavate existing grades below areas of proposed pavement as indicated in the Contract Documents and the Remedial Action Plan. Remove existing trees, roots, stumps, organic wetland soils, and top soil prior to placement of any fill and dispose of this material off-site in accordance with the project specifications. Import structural fill and compact in lifts in accordance with Section 31 08 00 to achieve subgrade elevations.

B. The Contractor shall drain any standing or puddled water in low lying areas.

C. Proof roll the subgrade below areas of proposed pavement with a minimum of 6 overlapping passes using the vibratory drum roller specified in part 2.2 of this Section prior to placement of pavement subbase. Areas which exhibit "pumping" or "rutting" under the action of the roller shall be removed and replaced with suitable fill material as specified in Section 31 08 00 of these Specifications, or as directed by the Owner's Engineer.

3.4 SUBGRADE FILL PLACEMENT AND COMPACTION

A. Fill material shall not be placed in areas of standing water, in areas of frozen or thawing ground, or in areas that have not been approved by the Owner's Engineer.

B. Fill materials shall not be placed during unfavorable weather conditions. When work is interrupted by heavy rains, fill operations shall not be resumed until all saturated surficial soils are returned to a satisfactory moisture content as determined by the Owner's Engineer.

C. Maintain optimum moisture content of fill materials as specified herein to attain required compaction density.

D. Materials shall be tested in accordance with Section 31 08 00.

E. If compaction requirements are not complied with at any time during construction process, remove and recompact deficient areas until proper compaction is obtained at no additional expense to Owner.

F. Fill surfaces shall be made smooth and free from ruts or indentations at the end of any work day when significant precipitation is forecast to prevent saturation of surficial fill material. Fill surfaces shall be graded to drain and sealed with a smooth drum roller at the completion of each work day.

G. Subgrade fill in paved areas shall be placed in uniform loose lifts and compacted in accordance with the Specifications.

H. Wet, saturated material shall be removed and replaced or scarified and air dried as necessary to achieve the field densities specified in this Section.

I. Prior to paving, the subgrade shall be proofrolled with a minimum of 6 overlapping passes using a 5-ton static drum weight vibratory roller.

J. Remove areas of finished subgrade found to have insufficient compaction density of depth necessary and replace with suitable compacted fill as approved by the Owner's Engineer. Surface of subgrade after compaction shall be hard, uniform, smooth, stable, and true to grade and cross-section.

3.5 MAINTENANCE OF APPROVED SUBGRADE SURFACES

A. Finished subgrades shall be verified to ensure proper elevation and conditions for construction above subgrade.

B. Protect subgrade and binder course from excessive wheel loading during construction including concrete trucks, dump trucks, and other construction equipment.

C. Remove areas of finished subgrade found to have insufficient compaction density to depth necessary and replace in manner that will comply with compaction requirements by use of material that has been approved by the Owner's Engineer. Surface of subgrade after compaction shall be hard, uniform, smooth, stable, and true to grade and cross-section.

3.6 FINISH GRADING

Finish grading shall be in accordance with Section 31 08 00.

3.7 QUALITY CONTROL

A. Compaction tests shall be performed as specified in Section 31 08 00.

B. Prior to paving, the finished subgrades shall be verified by the Contractor to ensure proper elevation and conditions for construction above subgrade.

C. Tolerances of 0.10 feet will be permitted. Any deviation from the design grades shall not result in changes in drainage areas or ponding. The Contractor shall provide engineering and field staking necessary for verification of lines, grades, and elevations.

END OF SECTION 31 23 16

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Part 5 – Stabilized Base Courses [NOT USED]

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Part 6 – Flexible Pavements

Item P-403 Asphalt Mix Pavement

Asphalt Mix Pavement shall be specified under the following Connecticut Department of Transportation based specifications:

32 12 16 – Asphaltic Concrete Paving

Appendix A

Referenced Sections of

Connecticut Department of Transportation

Standard Specifications for Roads, Bridges, Facilities and Incidental Construction - Form 819

METHOD OF MEASUREMENT

403-3.1 Asphaltic Concrete Paving will be measured based on the percentage of work completed as determined by the RPR.

BASIS OF PAYMENT

403-4.1 Asphaltic Concrete Paving will be measured based on the percentage of work completed as determined by the RPR. This price shall be full compensation for furnishing all materials, labor, equipment, tools, and incidentals necessary to complete the item.

Payment will be made under:

Item P-403	Asphaltic Concrete Paving

END OF ITEM P-403

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SECTION 32 12 16 – ASPHALTIC CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. General and Supplementary Conditions and Division 1 Specification Sections apply to this Section.

B. Section 31 23 16 - Excavation, Backfill, and Subgrade Preparation for Pavement

1.2 SCOPE OF WORK

A. Preparation and placement of asphaltic concrete binder course.

B. Preparation and placement of asphaltic concrete surface course.

1.3 REFERENCE STANDARDS

A. Connecticut Department of Transportation (CTDOT) Standard Specifications for Roads, Bridges and Incidental Construction, latest edition.

B. American Association of State Highway and Transportation Officials (AASHTO) Standard Specification for Transportation Materials and Methods of Sampling and Testing.

C. American Society of Testing and Materials (ASTM) latest edition.

D. Federal Aviation Administration AC 150/5370-10H – Standard Specifications for Construction of Airports.

1.4 QUALITY ASSURANCE

A. Perform the work in accordance with the latest revision of the CTDOT Standard Specifications.

B. Construct all pavements within public rights-of-way in accordance with the rules, regulations and requirements of the authority having jurisdiction of such right-of-way.

C. The Owner's Engineer may perform quality assurance testing of in-place asphaltic concrete courses for compliance with requirements for thickness, compaction, and surface smoothness. Asphaltic surface and base courses may be randomly cored for testing. Coring holes shall be immediately filled with full-depth asphaltic concrete.

D. Establish and maintain required lines and elevations.

E. In-place compacted thickness shall not be less than thickness specified on Contract Documents. Areas of deficient paving thickness shall receive tack coat and minimum 1-in. overlay; or shall be removed and replaced to proper thickness, at discretion of the Owner's Engineer; until specified thickness of course is met or exceeded at no additional expense to Owner.

F. Testing shall be performed on finished surface of each asphalt concrete course for smoothness, using 10-ft straightedge applied parallel with, and at right angles to center-line of paved area. Results of tests shall be made available to the Owner's Engineer upon request. Surfaces will not be acceptable if the following 10-ft straightedge tolerances for smoothness are exceeded:

1. Base Course Surface: 1/4-inch

2. Wearing Course Surface: 3/16-inch

G. Check surface areas at intervals necessary to eliminate ponding areas. Remove and replace unacceptable paving as directed by the Owner's Engineer.

H. Field density test for in-place materials shall be performed by examination of field cores in accordance with one of following standards:

1. Bulk specific gravity of paraffin-coated specimens: ASTM D 1188.

2. Bulk specific gravity using saturated surface-dry specimens: ASTM D 2726.

I. Rate of testing shall be 1 core per 20,000 sq. ft of pavement, with minimum of 3 cores. Cores shall be cut from areas representative of project. Areas of insufficient compaction shall be delineated, removed, and replaced in compliance with Specifications at no additional expense to Owner.

1.5 SUBMITTALS

A. Design Mix: Before any asphaltic concrete paving is constructed, submit actual design mix to the Owner's Engineer for review and approval. Design mix shall be CTDOT approved. Submittal shall include the type/name of the mix, sources of coarse aggregate, fine aggregate, mineral filler and PG binder, gradation analysis for aggregate used within final mixes and final aggregate mix blend, grade of asphalt cement used, voids in mineral aggregate (VMA), voids filled with asphalt (VFA), air void percent and effective asphalt content (percent). Mix design over three (3) years old will not be accepted by the Owner's Engineer.

B. Material Certificates: Submit materials certificate to the Owner's Engineer which is signed by material producer and Contractor, certifying that materials comply with, or exceed, the requirements herein.

C. Testing Results: Results of concrete, steel and paving tests performed by Contractor's testing laboratory shall be submitted to Owner's Engineer in a timely manner.

D. The results of tests for the day of installation shall be submitted to the Field Engineer with the first truck delivery each day of asphalt placement.

1.6 PROJECT CONDITIONS

A. Weather Limitations:

1. Apply prime and tack coats when ambient temperature is above 40 degrees Fahrenheit, and when temperature has been above 35 degrees Fahrenheit for 12 hours immediately prior to application. Do not apply when base is wet, contains excess moisture, or during rain.

2. Construct asphaltic concrete paving when atmospheric temperature is above 40 degrees Fahrenheit.

B. Maintain access for vehicular and pedestrian traffic as required for other construction activities. Utilize temporary striping, flagmen, barricades, warning signs, and warning lights as required.

PART 2 -PRODUCTS

2.1 MATERIALS

A. All materials shall conform to the applicable sections of the CTDOT Standard Specifications except as modified herein.

B. Aggregate Base Course: Crushed aggregate base course shall conform to the CTDOT Standard Specifications, Material M.05.01 processed aggregate base with no more than 8% passing the No. 200 sieve.

C. Asphalt Binder: AASHTO M 332, Performance Grade 64E-22.

D. Aggregate for Bituminous Concrete Surface Course: HMA S0.5, shall meet the requirements of Table M.04.02-3 for Traffic Level 2 per Section M.04 of the CTDOT Standard Specifications.

E. Aggregate for Bituminous Concrete Binder Course: HMA S1.0, shall meet the requirements of Table M.04.02-3 for Traffic Level 2 per Section M.04 of the CTDOT Standard Specifications.

F. Tack Coat: Emulsified asphalt; AASHTO M 140 or AASHTO M 208, SS-1h, CSS-1, or CSS-1h, diluted with 1 part water to 1 part emulsified asphalt.

G. Bituminous Concrete Surface Course: HMA S0.5, shall meet the requirements of Tables M.04.02-2, M.04.02-4 and M.04.02-5 for Traffic Level 2 per Section M.04 of the CTDOT Standard Specifications.

H. Bituminous Concrete Binder Course: HMA S1.0, shall meet the requirements of Tables M.04.02-2, M.04.02-4 and M.04.02-5 for Traffic Level 2 per Section M.04 of the CTDOT Standard Specifications.

I. Joint Sealant: ASTM D6690, Type 2, hot-applied, single-component, polymer-modified bituminous sealant.

J. Air voids: 4 +/- ½%

K. The use of reclaimed asphalt pavement (RAP) in new bituminous pavement will not be permitted.

L. Asphalt plants shall conform to the requirements of AASHTO M156 including plant inspections.

2.2 EQUIPMENT

Maintain equipment in satisfactory operating condition and correct breakdowns in manner that will not delay or be detrimental to progress of paving operations.

PART 3 - EXECUTION

3.1 PREPARATION

A. Proof roll prepared base material surface to check for unstable areas. Paving work shall begin only after unsuitable areas have been corrected and are ready to receive paving.

B. Remove loose material from compacted base material surface immediately before applying prime coat.

3.2 APPLICATIONS

A. Tack Coat:

1. Apply to contact surfaces of previously constructed asphaltic concrete base courses or Portland cement concrete and surfaces abutting or projecting into asphaltic concrete or into asphaltic concrete pavement.

2. Apply tack coat to asphaltic concrete base course. Apply emulsified asphalt tack coat between each lift or layer of full depth asphaltic concrete bases and on surface of bases where asphaltic concrete paving will be constructed.

3. Apply emulsified asphalt tack coat in accordance with CTDOT Standard Specifications.

4. Apply at minimum rate of 0.05 gal per sq. yd of surface.

5. Allow to dry until at proper condition to receive paving.

3.3 ASPHALTIC CONCRETE PLACEMENT

A. Place asphaltic concrete mixture on completed compacted subgrade surface, spread, and strike off. Do not place bituminous concrete pavement upon a wet surface. Ambient air temperature shall be at least 40 degrees F and rising. Delivery and mat temperature of the bituminous concrete mixes during paving operations shall be between 275 and 325 degrees F.

B. Whenever possible, pavement shall be spread by finishing machine; however, inaccessible or irregular areas may be placed by hand methods. Hot mixture shall be spread uniformly to required depth with hot shovels and rakes. After spreading, hot mixture shall be carefully smoothed to remove segregated course aggregate and rake marks. Rakes and lutes used for hand spreading shall be type designed for use on asphalt mixtures. Loads shall not be dumped faster that they can be properly spread. Workers shall not stand on loose mixture while spreading.

C. Paving Machine Placement: Apply successive lifts of asphaltic concrete in transverse directions with surface course placed parallel to flow of traffic. Place in typical strips not less than 10-ft wide.

D. Joints: Make joints between old and new pavements, or between successive days and work in manner that will provide continuous bond between adjoining work. Construction joints shall have same texture, density, and smoothness as other sections of asphaltic concrete course. Clean contact surfaces of joints and apply tack coat.

3.4 ROLLING AND COMPACTION

A. Mixture, after being spread, shall be thoroughly compacted by rolling as soon as it will bear the weight of rollers without undue displacement. Number, weight, types of rollers, and sequences of rolling operations shall be such that required density and surface are consistently attained while mixture is in workable condition.

B. The bituminous concrete pavement shall have a minimum thickness as specified on the Contract Documents and should be compacted to a minimum of 95.5% of the maximum theoretical specific gravity in accordance with AASHTO T209 and ASTM D2041 per CTDOT Standard Specifications.

C. Compact mixture with hot hand tampers or vibrating plate compactors in areas inaccessible to rollers.

D. Breakdown Rolling: Accomplish breakdown or initial rolling immediately following rolling of joints and outside edge. Check surface after breakdown rolling and repair displaced areas by loosening and filling with hot material.

E. Second Rolling: Follow breakdown rolling as soon as possible, while mixture is hot. Continue second rolling until mixture has been thoroughly compacted.

F. Finish Rolling: Perform finish rolling while mixture is still warm enough for removal of roller marks. Continue rolling until roller marks are eliminated and course has attained maximum density.

G. Patching: Remove and replace paving areas mixed with foreign materials and defective areas. Cut out such areas and fill with fresh, hot asphaltic concrete. Compact by rolling to maximum surface density and smoothness.

H. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

I. Scheduling: After complete placement of the base course the contractor may be required to remobilize for the placement of the top course. This schedule requirement will be based on the building progress, and fully at the discretion of the Owner's Engineer.

END OF SECTION 32 12 16

Part 7 – Rigid Pavement

Item P-501 Cement Concrete Pavement

DESCRIPTION

501-1.1 This work shall consist of pavement composed of cement concrete with reinforcement constructed on a prepared underlying surface in accordance with these specifications and shall conform to the lines, grades, thickness, and typical cross-sections shown on the plans. The terms cement concrete, hydraulic cement concrete, and concrete are interchangeable in this specification.

MATERIALS

501-2.1 Aggregates.

a. Reactivity. Fine and Coarse aggregates to be used in PCC on this project shall be tested and evaluated by the Contractor for alkali-aggregate reactivity in accordance with both ASTM C1260 and ASTM C1567. Tests must be representative of aggregate sources which will be providing material for production. ASTM C1260 and ASTM C1567 tests may be run concurrently.

(1) Coarse aggregate and fine aggregate shall be tested separately in accordance with ASTM C1260, however, the length of test shall be extended to 28 days (30 days from casting). Tests must have been completed within 6 months of the date of the concrete mix submittal.

(2) The combined coarse and fine aggregate shall be tested in accordance with ASTM C1567, modified for combined aggregates, using the proposed mixture design proportions of aggregates, cementitious materials, and/or specific reactivity reducing chemicals. If the expansion does not exceed 0.10% at 28 days, the proposed combined materials will be accepted. If the expansion is greater than 0.10% at 28 days, the aggregates will not be accepted unless adjustments to the combined materials mixture can reduce the expansion to less than 0.10% at 28 days, or new aggregates shall be evaluated and tested.

(3) If lithium nitrate is proposed for use with or without supplementary cementitious materials, the aggregates shall be tested in accordance with Corps of Engineers (COE) Concrete Research Division (CRD) C662 in lieu of ASTM C1567. If lithium nitrate admixture is used, it shall be nominal 30% ±0.5% weight lithium nitrate in water. If the expansion does not exceed 0.10% at 28 days, the proposed combined materials will be accepted. If the expansion is greater than 0.10% at 28 days, the aggregates will not be accepted unless adjustments to the combined materials mixture can reduce the expansion to less than 0.10% at 28 days, or new aggregates shall be evaluated and tested.

b. Fine aggregate. Grading of the fine aggregate, as delivered to the mixer, shall conform to the requirements of ASTM C33 and the parameters identified in the fine aggregate material requirements below. Fine aggregate material requirements and deleterious limits are shown in the table below.

Fine Aggregate Material Requirements		
Soundness of Aggregates by Use of Sodium Sulfate **or** Magnesium Sulfate	Loss after 5 cycles: 10% maximum using Sodium sulfate - or - 15% maximum using magnesium sulfate	ASTM C88
Sand Equivalent	45 minimum	ASTM D2419
Fineness Modulus (FM)	$2.50 \leq FM \leq 3.40$	ASTM C136
Limits for Deleterious Substances in Fine Aggregate for Concrete		
Clay lumps and friable particles	1.0% maximum	ASTM C142
Coal and lignite	0.5% using a medium with a density of Sp. Gr. of 2.0	ASTM C123
Total Deleterious Material	1.0% maximum	

c. Coarse aggregate. The maximum size coarse aggregate shall be one (1) inch.

Aggregates delivered to the mixer shall be clean, hard, uncoated aggregates consisting of crushed stone, crushed or uncrushed gravel, air-cooled iron blast furnace slag, crushed recycled concrete pavement, or a combination. The aggregates shall have no known history of detrimental pavement staining. Steel blast furnace slag shall not be permitted. Coarse aggregate material requirements and deleterious limits are shown in the table below; washing may be required to meet aggregate requirements.

Coarse Aggregate Material Requirements

Material Test	Requirement	Standard
Resistance to Degradation	Loss: 40% maximum	ASTM C131
Soundness of Aggregates by Use of Sodium Sulfate **or** Magnesium Sulfate	Loss after 5 cycles: 12% maximum using Sodium sulfate - or - 18% maximum using magnesium sulfate	ASTM C88
Flat, Elongated, or Flat and Elongated Particles	8% maximum, by weight, of flat, elongated, or flat and elongated particles at 5:1 for any size group coarser than 3/8 (9.5 mm) sieve [1]	ASTM D4791
Bulk density of slag [2]	Weigh not less than 70 pounds per cubic foot (1.12 Mg/cubic meter)	ASTM C29
D-cracking (Freeze-Thaw)[3]	Durability factor ≥ 95	ASTM C666

[1] A flat particle is one having a ratio of width to thickness greater than five (5); an elongated particle is one having a ratio of length to width greater than five (5).

[2] Only required if slag is specified.

[3] Coarse aggregate may only be accepted from sources that have a 20-year service history for the same gradation to be supplied with no history of D-Cracking. Aggregates that do not have a 20-year record of service free from major repairs (less than 5% of slabs replaced) in similar conditions without D-cracking shall not be used unless the material currently being produced has a durability factor greater than or equal to 95 per ASTM C666. The Contractor shall submit a current certification and test results to verify the aggregate acceptability. Test results will only be accepted from a State Department of Transportation (DOT) materials laboratory or an accredited

laboratory. Certification and test results which are not dated or which are over one (1) year old or which are for different gradations will not be accepted.

The amount of deleterious material in the coarse aggregate shall not exceed the following limits:

Limits for Deleterious Substances in Coarse Aggregate

Deleterious material	ASTM	Percentage by Mass
Clay Lumps and friable particles	ASTM C142	1.0
Material finer than No. 200 sieve (75 µm)	ASTM C117	1.0[1]
Lightweight particles	ASTM C123 using a medium with a density of Sp. Gr. of 2.0	0.5
Chert[2] (less than 2.40 Sp Gr.)	ASTM C123 using a medium with a density of Sp. Gr. of 2.40)	0.1[3]

[1] The limit for material finer than 75-µm is allowed to be increased to 1.5% for crushed aggregates consisting of dust of fracture that is essentially free from clay or shale. Test results supporting acceptance of increasing limit to 1.5% with statement indicating material is dust of fracture must be submitted with Concrete mix. Acceptable techniques to characterizing these fines include methylene blue adsorption or X-ray diffraction analysis.

[2] Chert and aggregates with less than 2.4 specific gravity.

[3] The limit for chert may be increased to 1.0 percent by mass in areas not subject to severe freeze and thaw.

d. Combined aggregate gradation. This specification is targeted for a combined aggregate gradation developed following the guidance presented in United States Air Force Engineering Technical Letter (ETL) 97-5: Proportioning Concrete Mixtures with Graded Aggregates for Rigid Airfield Pavements. Base the aggregate grading upon a combination of all the aggregates (coarse and fine) to be used for the mixture proportioning. Three aggregate sizes may be required to achieve an optimized combined gradation that will produce a workable concrete mixture for its intended use. Use aggregate gradations that produce concrete mixtures with well-graded or optimized aggregate combinations. The Contractor shall submit complete mixture information necessary to calculate the volumetric components of the mixture. The combined aggregate grading shall meet the following requirements:

(1) The materials selected and the proportions used shall be such that when the Coarseness Factor (CF) and the Workability Factor (WF) are plotted on a diagram as described in paragraph 501-2.1d(4) below, the point thus determined shall fall within the parallelogram described therein.

(2) The CF shall be determined from the following equation:

CF = (cumulative percent retained on the 3/8 in. (9.5 mm) sieve)(100) / (cumulative percent retained on the No. 8 (2.36 mm) sieve)

(3) The WF is defined as the percent passing the No. 8 (2.36 mm) sieve based on the combined gradation. However, WF shall be adjusted, upwards only, by 2.5 percentage points for each 94 pounds (42 kg) of cementitious material per cubic meter yard greater than 564 pounds per cubic yard (335 kg per cubic meter).

(4) A diagram shall be plotted using a rectangular scale with WF on the Y-axis with units from 20 (bottom) to 45 (top), and with CF on the X-axis with units from 80 (left side) to 30 (right side). On this diagram a parallelogram shall be plotted with corners at the following coordinates (CF-75, WF-28), (CF-75, WF-40), (CF-45, WF-32.5), and (CF-45, WF-44.5). If the point determined by the intersection of the computed CF and WF does not fall within the above parallelogram, the grading of each size of aggregate

used and the proportions selected shall be changed as necessary. The point determined by the plotting of the CF and WF may be adjusted during production ±3 WF and ±5 CF. Adjustments to gradation may not take the point outside of the parallelogram.

e. Contractors combined aggregate gradation. The Contractor shall submit their combined aggregate gradation using the following format:

Contractor's Combined Aggregate Gradation

Sieve Size	Contractor's Concrete mix Gradation (Percent passing by weight)
2 inch (50 mm)	*
1-1/2 inch (37.5 mm)	*
1 inch (25.0 mm)	*
3/4 inch (19.0 mm)	*
1/2 inch (12.5 mm)	*
3/8 inch (9.5 mm)	*
No. 4 (4.75 mm)	*
No. 8 (2.36 mm)	*
No. 16 (1.18 mm)	*
No. 30 (600 µm)	*
No. 50 (300 µm)	*
No. 100 (150 µm)	*

501-2.2 Cement. Cement shall conform to the requirements of ASTM C150 Type II.

501-2.3 Cementitious materials.

a. Fly ash. Fly ash shall meet the requirements of ASTM C618, with the exception of loss of ignition, where the maximum shall be less than 6%. Fly ash shall have a Calcium Oxide (CaO) content of less than 15% and a total alkali content less than 3% per ASTM C311. The Contractor shall furnish the previous three most recent, consecutive ASTM C618 reports for each source of fly ash proposed in the concrete mix, and shall furnish each additional report as they become available during the project. The reports can be used for acceptance or the material may be tested independently by the Resident Project Representative (RPR).

b. Slag cement (ground granulated blast furnace (GGBF). Slag cement shall conform to ASTM C989, Grade 100 or Grade 120. Slag cement shall be used only at a rate between 25% and 55% of the total cementitious material by mass.

c. Raw or calcined natural pozzolan. Natural pozzolan shall be raw or calcined and conform to ASTM C618, Class N, including the optional requirements for uniformity and effectiveness in controlling Alkali-Silica reaction and shall have a loss on ignition not exceeding 6%. Class N pozzolan for use in mitigating Alkali-Silica Reactivity shall have a total available alkali content less than 3%.

501-2.4 Joint seal. The joint seal for the joints in the concrete pavement shall meet the requirements of Item P-605 and shall be of the type specified in the plans.

501-2.5 Isolation joint filler. Premolded joint filler for isolation joints shall conform to the requirements of ASTM D1751 or ASTM D1752 and shall be where shown on the plans. The filler for each joint shall be furnished in a single piece for the full depth and width required for the joint, unless otherwise specified by the RPR. When the use of more than one piece is required for a joint, the abutting ends shall be fastened securely and held accurately to shape by stapling or other positive fastening means satisfactory to the RPR.

501-2.6 Steel reinforcement. Reinforcing shall consist of Plain-Steel Welded Wire Reinforcement:, fabricated from galvanized wire into flat sheets conforming to the requirements of ASTM A 185/A 185M.

501-2.7 Dowel and tie bars. Dowel bars shall be plain steel bars conforming to ASTM A615 and shall be free from burring or other deformation restricting slippage in the concrete.

a. Dowel Bars. Before delivery to the construction site each dowel bar shall be epoxy coated per ASTM A1078, Type 1, with a coating thickness after curing greater than 10 mils. Patched ends are not required for Type 1 coated dowels. The dowels shall be coated with a bond-breaker recommended by the manufacturer. Dowel sleeves or inserts are not permitted. Grout retention rings shall be fully circular metal or plastic devices capable of supporting the dowel until the grout hardens.

b. Tie Bars. Tie bars shall be deformed steel bars and conform to the requirements of ASTM A615. Tie bars designated as Grade 60 in ASTM A615 or ASTM A706 shall be used for construction requiring bent bars.

501-2.8 Water. Water used in mixing or curing shall be potable. If water is taken from other sources considered non-potable, it shall meet the requirements of ASTM C1602.

501-2.9 Material for curing concrete. Curing materials shall conform to one of the following specifications:

a. Liquid membrane-forming compounds for curing concrete shall conform to the requirements of ASTM C309, Type 2, Class A, or Class B.

b. White polyethylene film for curing concrete shall conform to the requirements of ASTM C171.

c. White burlap-polyethylene sheeting for curing concrete shall conform to the requirements of ASTM C171.

d. Waterproof paper for curing concrete shall conform to the requirements of ASTM C171.

501-2.10 Admixtures. Admixtures shall conform to the following specifications:

a. Air-entraining admixtures. Air-entraining admixtures shall meet the requirements of ASTM C260 and shall consistently entrain the air content in the specified ranges under field conditions. The air-entraining agent and any water reducer admixture shall be compatible.

b. Water-reducing admixtures. Water-reducing admixture shall meet the requirements of ASTM C494, Type A, B, or D.

c. Other admixtures. The use of set retarding and set-accelerating admixtures shall be approved by the RPR prior to developing the concrete mix. Retarding admixtures shall meet the requirements of ASTM C494, Type A, B, or D and set-accelerating admixtures shall meet the requirements of ASTM C494, Type C. Calcium chloride and admixtures containing calcium chloride shall not be used.

d. Lithium Nitrate. The lithium admixture shall be a nominal 30% aqueous solution of Lithium Nitrate, with a density of 10 pounds/gallon (1.2 kg/L), and shall have the approximate chemical form as shown below:

Lithium Admixture

Constituent	Limit (Percent by Mass)
LiNO3 (Lithium Nitrate)	30 ±0.5
SO4 (Sulfate Ion)	0.1 (max)
Cl (Chloride Ion)	0.2 (max)
Na (Sodium Ion)	0.1 (max)
K (Potassium Ion)	0.1 (max)

The lithium nitrate admixture dispensing and mixing operations shall be verified and certified by the lithium manufacturer's representative.

501-2.11 Epoxy-resin. All epoxy-resin materials shall be two-component materials conforming to the requirements of ASTM C881, Class as appropriate for each application temperature to be encountered, except that in addition, the materials shall meet the following requirements:

a. Material for use for embedding dowels and anchor bolts shall be Type IV, Grade 3.

b. Material for use as patching materials for complete filling of spalls and other voids and for use in preparing epoxy resin mortar shall be Type III, Grade as approved.

c. Material for use for injecting cracks shall be Type IV, Grade 1.

d. Material for bonding freshly mixed Portland cement concrete or mortar or freshly mixed epoxy resin concrete or mortar to hardened concrete shall be Type V, Grade as approved.

501-2.12 Bond Breaker. Liquid membrane forming compound shall be in accordance with paragraph 501-2.7.

CONCRETE MIX

501-3.1. General. No concrete shall be placed until an acceptable concrete mix has been submitted to the RPR for review and the RPR has taken appropriate action. The RPR's review shall not relieve the Contractor of the responsibility to select and proportion the materials to comply with this section.

501-3.2 Concrete Mix Laboratory. The laboratory used to develop the concrete mix shall be accredited in accordance with ASTM C1077. The laboratory accreditation must be current and listed on the accrediting authority's website. All test methods required for developing the concrete mix must be included in the lab accreditation. A copy of the laboratory's current accreditation and accredited test methods shall be submitted to the RPR prior to start of construction.

501-3.3 Concrete Mix Proportions. Develop the mix using the procedures contained in Portland Cement Association (PCA) publication, "Design and Control of Concrete Mixtures." Concrete shall be proportioned to achieve a 28-day flexural strength that meets or exceeds the acceptance criteria contained in paragraph 501-6.6 for a flexural strength of 4,500 psi per ASTM C78.

The minimum cementitious material shall be adequate to ensure a workable, durable mix. The minimum cementitious material (cement plus fly ash, or slag cement) shall be 615 pounds per cubic yard (365 kg per cubic meter). The ratio of water to cementitious material, including free surface moisture on the aggregates but not including moisture absorbed by the aggregates shall be between 0.38 – 0.45 by weight.

Flexural strength test specimens shall be prepared in accordance with ASTM C192 and tested in accordance with ASTM C78. At the start of the project, the Contractor shall determine an allowable

slump as determined by ASTM C143 not to exceed 2 inches (50 mm) for slip-form placement. For fixed-form placement, the slump shall not exceed 3 inches (75 mm). For hand placement, the slump shall not exceed 4 inches (100 mm).

The results of the concrete mix shall include a statement giving the maximum nominal coarse aggregate size and the weights and volumes of each ingredient proportioned on a one cubic yard (meter) basis. Aggregate quantities shall be based on the mass in a saturated surface dry condition.

If a change in source(s) is made, or admixtures added or deleted from the mix, a new concrete mix must be submitted to the RPR for approval.

The RPR may request samples at any time for testing, prior to and during production, to verify the quality of the materials and to ensure conformance with the applicable specifications.

501-3.4 Concrete Mix submittal. The concrete mix shall be submitted to the RPR at least 30 days prior to the start of operations. The submitted concrete mix shall not be more than 180 days old and must use the materials to be used for production for the project. Production shall not begin until the concrete mix is approved in writing by the RPR.

Each of the submitted concrete mixes (i.e, slip form, side form machine finish and side form hand finish) shall be stamped or sealed by the responsible professional Engineer of the laboratory and shall include the following items and quantities as a minimum:

- Certified material test reports for aggregate in accordance with paragraph 501-2.1. Certified reports must include all tests required; reporting each test, test method, test result, and requirement specified (criteria).
- Combined aggregate gradations and analysis; and including plots of the fine aggregate fineness modulus.
- Reactivity Test Results.
- Coarse aggregate quality test results, including deleterious materials.
- Fine aggregate quality test results, including deleterious materials.
- Mill certificates for cement and supplemental cementitious materials.
- Certified test results for all admixtures, including Lithium Nitrate if applicable.
- Specified flexural strength, slump, and air content.
- Recommended proportions/volumes for proposed mixture and trial water-cementitious materials ratio, including actual slump and air content.
- Flexural and compressive strength summaries and plots, including all individual beam and cylinder breaks.
- Correlation ratios for acceptance testing and Contractor QC testing, when applicable.
- Historical record of test results documenting production standard deviation, when applicable.

501-3.5 Cementitious materials.

a. Fly ash. When fly ash is used as a partial replacement for cement, the replacement rate shall be determined from laboratory trial mixes, and shall be between 20 and 30% by weight of the total cementitious material. If fly ash is used in conjunction with slag cement the maximum replacement rate shall not exceed 10% by weight of total cementitious material.

b. Slag cement (ground granulated blast furnace (GGBF)). Slag cement may be used. The slag cement, or slag cement plus fly ash if both are used, may constitute between 25 to 55% of the total cementitious material by weight.

c. Raw or calcined natural pozzolan. Natural pozzolan may be used in the concrete mix. When pozzolan is used as a partial replacement for cement, the replacement rate shall be determined from laboratory trial mixes, and shall be between 20 and 30% by weight of the total cementitious material. If pozzolan is used in conjunction with slag cement the maximum replacement rate shall not exceed 10% by weight of total cementitious material.

501-3.6 Admixtures.

a. Air-entraining admixtures. Air-entraining admixture are to be added in such a manner that will ensure uniform distribution of the agent throughout the batch. The air content of freshly mixed air-entrained concrete shall be based upon trial mixes with the materials to be used in the work adjusted to produce concrete of the required plasticity and workability. The percentage of air in the mix shall be 5-7 percent. Air content shall be determined by testing in accordance with ASTM C231 for gravel and stone coarse aggregate and ASTM C173 for slag and other highly porous coarse aggregate.

b. Water-reducing admixtures. Water-reducing admixtures shall be added to the mix in the manner recommended by the manufacturer and in the amount necessary to comply with the specification requirements. Tests shall be conducted with the materials to be used in the work, in accordance with ASTM C494.

c. Other admixtures. Set controlling, and other approved admixtures shall be added to the mix in the manner recommended by the manufacturer and in the amount necessary to comply with the specification requirements. Tests shall be conducted with the materials to be used in the work, in accordance with ASTM C494.

d. Lithium nitrate. Lithium nitrate shall be added to the mix in the manner recommended by the manufacturer and in the amount necessary to comply with the specification requirements in accordance with paragraph 501-2.10d.

CONSTRUCTION METHODS

501-4.1 Control Strip. The control strip(s) shall be to the next planned joint after the initial 250 feet (75 m) of each type of pavement construction (slip-form pilot lane, slip-form fill-in lane, or fixed form). The Contractor shall demonstrate, in the presence of the RPR, that the materials, concrete mix, equipment, construction processes, and quality control processes meet the requirements of the specifications. The concrete mixture shall be extruded from the paver meeting the edge slump tolerance and with little or no finishing. Pilot, fill-in, and fixed-form control strips will be accepted separately. Minor adjustments to the mix design may be required to place an acceptable control strip. The production mix will be the adjusted mix design used to place the acceptable control strip. Upon acceptance of the control strip by the RPR, the Contractor must use the same equipment, materials, and construction methods for the remainder of concrete paving. Any adjustments to processes or materials must be approved in advance by the RPR. Acceptable control strips will meet edge slump tolerance and surface acceptable with little or no finishing, air content within action limits, strength equal or greater than requirements of P501-3.3. The control strip will be considered one lot for payment (no sublots required for control strip). Payment will only be made for an acceptable control strip in accordance with paragraph 501-8.1 using a lot pay factor equal to 100.

501-4.2 Equipment. The Contractor is responsible for the proper operation and maintenance of all equipment necessary for handling materials and performing all parts of the work to meet this specification.

a. Plant and equipment. The plant and mixing equipment shall conform to the requirements of ASTM C94 and/or ASTM C685. Each truck mixer shall have attached in a prominent place a manufacturer's nameplate showing the capacity of the drum in terms of volume of mixed concrete and the speed of rotation of the mixing drum or blades. The truck mixers shall be examined daily for changes in condition due to accumulation of hard concrete or mortar or wear of blades. The pickup and throwover blades shall be replaced when they have worn down 3/4 inch (19 mm) or more. The Contractor shall have a copy of the manufacturer's design on hand showing dimensions and arrangement of blades in reference to original height and depth.

Equipment for transferring and spreading concrete from the transporting equipment to the paving lane in front of the finishing equipment shall be provided. The equipment shall be specially manufactured, self-propelled transfer equipment which will accept the concrete outside the paving lane and will spread it evenly across the paving lane in front of the paver and strike off the surface evenly to a depth which permits the paver to operate efficiently.

b. Finishing equipment.

(1) Slip-form. The standard method of constructing concrete pavements shall be with an approved slip-form paving equipment designed and operated to spread, consolidate, screed, and finish the freshly placed concrete in one complete pass of the machine so that the end result is a dense and homogeneous pavement which is achieved with a minimum of hand finishing. The paver-finisher shall be a heavy duty, self-propelled machine designed specifically for paving and finishing high quality concrete pavements.

(2) Fixed-form. On projects requiring less than 10,000 cubic yards (7650 cubic meters) of concrete pavement or irregular areas at locations inaccessible to slip-form paving equipment, concrete pavement may be placed with equipment specifically designed for placement and finishing using stationary side forms. Methods and equipment shall be reviewed and accepted by the RPR. Hand screeding and float finishing may only be used on small irregular areas as allowed by the RPR.

c. Vibrators. Vibrator shall be the internal type. The rate of vibration of each vibrating unit shall be sufficient to consolidate the pavement without segregation or voids. The number, spacing, and frequency shall be as necessary to provide a dense and homogeneous pavement and meet the recommendations of American Concrete Institute (ACI) 309R, Guide for Consolidation of Concrete. Adequate power to operate all vibrators shall be available on the paver. The vibrators shall be automatically controlled so that they shall be stopped as forward motion ceases. The Contractor shall provide an electronic or mechanical means to monitor vibrator status. The checks on vibrator status shall occur a minimum of two times per day or when requested by the RPR.

Hand held vibrators may only be used in irregular areas and shall meet the recommendations of ACI 309R, Guide for Consolidation of Concrete.

d. Concrete saws. The Contractor shall provide sawing equipment adequate in number of units and power to complete the sawing to the required dimensions. The Contractor shall provide at least one standby saw in good working order and a supply of saw blades at the site of the work at all times during sawing operations.

e. Fixed forms. Straight side fixed forms shall be made of steel and shall be furnished in sections not less than 10 feet (3 m) in length. Forms shall be provided with adequate devices for secure settings so that when in place they will withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms with battered top surfaces and bent, twisted or broken forms shall not be used. Built-up forms shall not be used, except as approved by the RPR. The top face of the form shall not vary from a true plane more than 1/8 inch (3 mm) in 10 feet (3 m), and the upstanding leg shall not vary more than 1/4 inch (6 mm). The forms shall contain provisions for locking the ends of

abutting sections together tightly for secure setting. Wood forms may be used under special conditions, when approved by the RPR. The forms shall extend the full depth of the pavement section.

501-4.3 Form setting. Forms shall be set to line and grade as shown on the plans, sufficiently in advance of the concrete placement, to ensure continuous paving operation. Forms shall be set to withstand, without visible spring or settlement, the impact and vibration of the consolidating and finishing equipment. Forms shall be cleaned and oiled prior to the concrete placement.

501-4.4 Base surface preparation prior to placement. Any damage to the prepared base, subbase, and subgrade shall be corrected full depth by the Contractor prior to concrete placement. The underlying surface shall be entirely free of frost when concrete is placed. The prepared grade shall be moistened with water, without saturating, immediately ahead of concrete placement to prevent rapid loss of moisture from concrete.

501-4.5 Handling, measuring, and batching material. Aggregate stockpiles shall be constructed and managed in such a manner that prevents segregation and intermixing of deleterious materials. Aggregates from different sources shall be stockpiled, weighed and batched separately at the concrete batch plant. Aggregates that have become segregated or mixed with earth or foreign material shall not be used. All aggregates produced or handled by hydraulic methods, and washed aggregates, shall be stockpiled or binned for draining at least 12 hours before being batched. Store and maintain all aggregates at a uniform moisture content prior to use. A continuous supply of materials shall be provided to the work to ensure continuous placement.

501-4.6 Mixing concrete. The concrete may be mixed at the work site, in a central mix plant or in truck mixers. The mixer shall be of an approved type and capacity. Mixing time shall be measured from the time all materials are placed into the drum until the drum is emptied into the truck. All concrete shall be mixed and delivered to the site in accordance with the requirements of ASTM C94 or ASTM C685.

Mixed concrete from the central mixing plant shall be transported in truck mixers, truck agitators, or non-agitating trucks. The elapsed time from the addition of cementitious material to the mix until the concrete is discharged from the truck should not exceed 30 minutes when the concrete is hauled in non-agitating trucks, nor 90 minutes when the concrete is hauled in truck mixers or truck agitators. In no case shall the temperature of the concrete when placed exceed 90°F (32°C). Retempering concrete by adding water or by other means will not be permitted. With transit mixers additional water may be added to the batch materials and additional mixing performed to increase the slump to meet the specified requirements provided the addition of water is performed within 45 minutes after the initial mixing operations and provided the water/cementitious ratio specified is not exceeded.

501-4.7 Weather Limitations on mixing and placing. No concrete shall be mixed, placed, or finished when the natural light is insufficient, unless an adequate and approved artificial lighting system is operated.

a. Cold weather. Unless authorized in writing by the RPR, mixing and concreting operations shall be discontinued when a descending air temperature in the shade and away from artificial heat reaches 40°F (4°C) and shall not be resumed until an ascending air temperature in the shade and away from artificial heat reaches 35°F (2°C).

The aggregate shall be free of ice, snow, and frozen lumps before entering the mixer. The temperature of the mixed concrete shall not be less than 50°F (10°C) at the time of placement. Concrete shall not be placed on frozen material nor shall frozen aggregates be used in the concrete.

When concreting is authorized during cold weather, water and/or the aggregates may be heated to not more than 150°F (66°C). The apparatus used shall heat the mass uniformly and shall be arranged to preclude the possible occurrence of overheated areas which might be detrimental to the materials.

Curing during cold weather shall be in accordance with paragraph 501-4.13d.

b. Hot weather. During periods of hot weather when the maximum daily air temperature exceeds 85°F (30°C), the following precautions shall be taken.

The forms and/or the underlying surface shall be sprinkled with water immediately before placing the concrete. The concrete shall be placed at the coolest temperature practicable, and in no case shall the temperature of the concrete when placed exceed 90°F (32°C). The aggregates and/or mixing water shall be cooled as necessary to maintain the concrete temperature at or not more than the specified maximum.

The concrete placement shall be protected from exceeding an evaporation rate of 0.2 psf (0.98 kg/m^2 per hour) per hour. When conditions are such that problems with plastic cracking can be expected, and particularly if any plastic cracking begins to occur, the Contractor shall immediately take such additional measures as necessary to protect the concrete surface. If the Contractor's measures are not effective in preventing plastic cracking, paving operations shall be immediately stopped.

Curing during hot weather shall be in accordance with paragraph 501-4.13e.

c. Temperature management program. Prior to the start of paving operation for each day of paving, the Contractor shall provide the RPR with a Temperature Management Program for the concrete to be placed to assure that uncontrolled cracking is avoided. (Federal Highway Administration HIPERPAV 3 is one example of a temperature management program.) As a minimum, the program shall address the following items:

(1) Anticipated tensile strains in the fresh concrete as related to heating and cooling of the concrete material.

(2) Anticipated weather conditions such as ambient temperatures, wind velocity, and relative humidity; and anticipated evaporation rate using Figure 19-9, PCA, Design and Control of Concrete Mixtures.

(3) Anticipated timing of initial sawing of joint.

(4) Anticipated number and type of saws to be used.

d. **Rain.** The Contractor shall have available materials for the protection of the concrete during inclement weather. Such protective materials shall consist of rolled polyethylene sheeting at least 4 mils (0.1 mm) thick of sufficient length and width to cover the plastic concrete slab and any edges. The sheeting may be mounted on either the paver or a separate movable bridge from which it can be unrolled without dragging over the plastic concrete surface. When rain appears imminent, all paving operations shall stop and all available personnel shall begin covering the surface of the unhardened concrete with the protective covering.

501-4.8 Concrete Placement. At any point in concrete conveyance, the free vertical drop of the concrete from one point to another or to the underlying surface shall not exceed 3 feet (1 m). The finished concrete product must be dense and homogeneous, without segregation and conforming to the standards in this specification. Backhoes and grading equipment shall not be used to distribute the concrete in front of the paver. Front end loaders will not be used. All concrete shall be consolidated without voids or segregation, including under and around all load-transfer devices, joint assembly units, and other features embedded in the pavement. Hauling equipment or other mechanical equipment can be permitted on adjoining previously constructed pavement when the concrete strength reaches a compressive strength of 3,100 psi (21.4 MPa), based on the average of four field cured specimens per 2,000 cubic yards (1,530 cubic meters) of concrete placed. The Contractor must determine that the above minimum strengths are adequate to protection the pavement from overloads due to the construction equipment proposed for the project.

The Contractor shall have available materials for the protection of the concrete during cold, hot and/or inclement weather in accordance with paragraph 501-4.7.

a. Slip-form construction. The concrete shall be distributed uniformly into final position by a self-propelled slip-form paver without delay. The alignment and elevation of the paver shall be regulated from outside reference lines established for this purpose. The paver shall vibrate the concrete for the full width and depth of the strip of pavement being placed and the vibration shall be adequate to provide a consistency of concrete that will stand normal to the surface with sharp well-defined edges. The sliding forms shall be rigidly held together laterally to prevent spreading of the forms. The plastic concrete shall be effectively consolidated by internal vibration with transverse vibrating units for the full width of the pavement and/or a series of equally placed longitudinal vibrating units. The space from the outer edge of the pavement to longitudinal unit shall not exceed 9 inches (23 cm) for slipform and at the end of the dowels for the fill-in lanes. The spacing of internal units shall be uniform and shall not exceed 18 inches (0.5 m).

The term internal vibration means vibrating units located within the specified thickness of pavement section.

The rate of vibration of each vibrating unit shall be sufficient to consolidate the pavement without, segregation, voids, or vibrator trails and the amplitude of vibration shall be sufficient to be perceptible on the surface of the concrete along the entire length of the vibrating unit and for a distance of at least one foot (30 cm). The frequency of vibration or amplitude should be adjusted proportionately with the rate of travel to result in a uniform density and air content. The paving machine shall be equipped with a tachometer or other suitable device for measuring and indicating the actual frequency of vibrations.

The concrete shall be held at a uniform consistency. The slip-form paver shall be operated with as nearly a continuous forward movement as possible and all operations of mixing, delivering, and spreading concrete shall be coordinated to provide uniform progress with stopping and starting of the paver held to a minimum. If for any reason, it is necessary to stop the forward movement of the paver, the vibratory and tamping elements shall also be stopped immediately. No tractive force shall be applied to the machine, except that which is controlled from the machine.

When concrete is being placed adjacent to an existing pavement, that part of the equipment which is supported on the existing pavement shall be equipped with protective pads on crawler tracks or rubber-tired wheels on which the bearing surface is offset to run a sufficient distance from the edge of the pavement to avoid breaking the pavement edge.

Not more than 15% of the total free edge of each 500-foot (150 m) segment of pavement, or fraction thereof, shall have an edge slump exceeding 1/4 inch (6 mm), and none of the free edge of the pavement shall have an edge slump exceeding 3/8 inch (9 mm). (The total free edge of 500 feet (150 m) of pavement will be considered the cumulative total linear measurement of pavement edge originally constructed as nonadjacent to any existing pavement; that is, 500 feet (150 m) of paving lane originally constructed as a separate lane will have 1,000 feet (300 m) of free edge, 500 feet (150 m) of fill-in lane will have no free edge, etc.). The area affected by the downward movement of the concrete along the pavement edge shall be limited to not more than 18 inches (0.5 m) from the edge.

When excessive edge slump cannot be corrected before the concrete has hardened, the area with excessive edge slump will be removed the full width of the slip form lane and replaced at the expense of the Contractor as directed by the RPR.

b. Fixed-form construction. Forms shall be drilled in advance of being placed to line and grade to accommodate tie bars / dowel bars where these are specified.

Immediately in advance of placing concrete and after all subbase operations are completed, side forms shall be trued and maintained to the required line and grade for a distance sufficient to prevent delay in placing.

Side forms shall remain in place at least 12 hours after the concrete has been placed, and in all cases until the edge of the pavement no longer requires the protection of the forms. Curing compound shall be applied to the concrete immediately after the forms have been removed.

Side forms shall be thoroughly cleaned and coated with a release agent each time they are used and before concrete is placed against them.

Concrete shall be spread, screed, shaped and consolidated by one or more self-propelled machines. These machines shall uniformly distribute and consolidate concrete without segregation so that the completed pavement will conform to the required cross-section with a minimum of handwork.

The number and capacity of machines furnished shall be adequate to perform the work required at a rate equal to that of concrete delivery. The equipment must be specifically designed for placement and finishing using stationary side forms. Methods and equipment shall be reviewed and accepted by the RPR.

Concrete for the full paving width shall be effectively consolidated by internal vibrators. The rate of vibration of each vibrating unit shall be sufficient to consolidate the pavement without segregation, voids, or leaving vibrator trails.

Power to vibrators shall be connected so that vibration ceases when forward or backward motion of the machine is stopped.

c. Consolidation. Concrete shall be consolidated with the specified type of lane-spanning, gang-mounted, mechanical, immersion type vibrating equipment mounted in front of the paver, supplemented, in rare instances as specified, by hand-operated vibrators. The vibrators shall be inserted into the concrete to a depth that will provide the best full-depth consolidation but not closer to the underlying material than 2 inches (50 mm). Vibrators shall not be used to transport or spread the concrete. For each paving train, at least one additional vibrator spud, or sufficient parts for rapid replacement and repair of vibrators shall be maintained at the paving site at all times. Any evidence of inadequate consolidation (honeycomb along the edges, large air pockets, or any other evidence) or over-consolidation (vibrator trails, segregation, or any other evidence) shall require the immediate stopping of the paving operation and adjustment of the equipment or procedures as approved by the RPR.

If a lack of consolidation of the hardened concrete is suspected by the RPR, referee testing may be required. Referee testing of hardened concrete will be performed by the RPR by cutting cores from the finished pavement after a minimum of 24 hours curing. The RPR shall visually examine the cores for evidence of lack of consolidation. Density determinations will be made by the RPR based on the water content of the core as taken. ASTM C642 shall be used for the determination of core density in the saturated-surface dry condition. When required, referee cores will be taken at the minimum rate of one for each 500 cubic yards (382 m^2) of pavement, or fraction. The Contractor shall be responsible for all referee testing cost if they fail to meet the required density.

The average density of the cores shall be at least 97% of the original concrete mix density, with no cores having a density of less than 96% of the original concrete mix density. Failure to meet the referee tests will be considered evidence that the minimum requirements for vibration are inadequate for the job conditions. Additional vibrating units or other means of increasing the effect of vibration shall be employed so that the density of the hardened concrete conforms to the above requirements.

501-4.9 Strike-off of concrete and placement of reinforcement. Following the placing of the concrete, it shall be struck off to conform to the cross-section shown on the plans and to an elevation that when the concrete is properly consolidated and finished, the surface of the pavement shall be at the elevation shown on the plans. When reinforced concrete pavement is placed in two layers, the bottom layer shall be struck off to such length and depth that the sheet of reinforcing steel fabric or bar mat may be laid full length on the concrete in its final position without further manipulation. The reinforcement shall then be placed

directly upon the concrete, after which the top layer of the concrete shall be placed, struck off, and screed. If any portion of the bottom layer of concrete has been placed more than 30 minutes without being covered with the top layer or if initial set has taken place, it shall be removed and replaced with freshly mixed concrete at the Contractor's expense. When reinforced concrete is placed in one layer, the reinforcement may be positioned in advance of concrete placement or it may be placed in plastic concrete by mechanical or vibratory means after spreading.

Reinforcing steel, at the time concrete is placed, shall be free of mud, oil, or other organic matter that may adversely affect or reduce bond. Reinforcing steel with rust, mill scale or a combination of both will be considered satisfactory, provided the minimum dimensions, weight, and tensile properties of a hand wire-brushed test specimen are not less than the applicable ASTM specification requirements.

501-4.10 Joints. Joints shall be constructed as shown on the plans and in accordance with these requirements. All joints shall be constructed with their faces perpendicular to the surface of the pavement and finished or edged as shown on the plans. Joints shall not vary more than 1/2-inch (12 mm) from their designated position and shall be true to line with not more than 1/4-inch (6 mm) variation in 10 feet (3 m). The surface across the joints shall be tested with a 12-foot (3 m) straightedge as the joints are finished and any irregularities in excess of 1/4 inch (6 mm) shall be corrected before the concrete has hardened. All joints shall be so prepared, finished, or cut to provide a groove of uniform width and depth as shown on the plans.

a. Construction. Longitudinal construction joints shall be slip-formed or formed against side forms as shown in the plans.

Transverse construction joints shall be installed at the end of each day's placing operations and at any other points within a paving lane when concrete placement is interrupted for more than 30 minutes or it appears that the concrete will obtain its initial set before fresh concrete arrives. The installation of the joint shall be located at a planned contraction or expansion joint. If placing of the concrete is stopped, the Contractor shall remove the excess concrete back to the previous planned joint.

b. Contraction. Contraction joints shall be installed at the locations and spacing as shown on the plans. Contraction joints shall be installed to the dimensions required by forming a groove or cleft in the top of the slab while the concrete is still plastic or by sawing a groove into the concrete surface after the concrete has hardened. When the groove is formed in plastic concrete the sides of the grooves shall be finished even and smooth with an edging tool. If an insert material is used, the installation and edge finish shall be according to the manufacturer's instructions. The groove shall be finished or cut clean so that spalling will be avoided at intersections with other joints. Grooving or sawing shall produce a slot at least 1/8 inch (3 mm) wide and to the depth shown on the plans.

c. Isolation (expansion). Isolation joints shall be installed as shown on the plans. The premolded filler of the thickness as shown on the plans, shall extend for the full depth and width of the slab at the joint. The filler shall be fastened uniformly along the hardened joint face with no buckling or debris between the filler and the concrete interface, including a temporary filler for the sealant reservoir at the top of the slab. The edges of the joint shall be finished and tooled while the concrete is still plastic

d. Dowels and Tie Bars for Joints

(1) Tie bars. Tie bars shall consist of deformed bars installed in joints as shown on the plans. Tie bars shall be placed at right angles to the centerline of the concrete slab and shall be spaced at intervals shown on the plans. They shall be held in position parallel to the pavement surface and in the middle of the slab depth and within the tolerances in paragraph 501-4.10(f.). When tie bars extend into an unpaved lane, they may be bent against the form at longitudinal construction joints, unless threaded bolt or other assembled tie bars are specified. Tie bars shall not be painted, greased, or enclosed in sleeves. When slip-form operations call for tie bars, two-piece hook bolts can be installed.

(2) Dowel bars. Dowel bars shall be placed across joints in the proper horizontal and vertical alignment as shown on the plans. The dowels shall be coated with a bond-breaker or other lubricant recommended by the manufacturer and approved by the RPR. Dowels bars at longitudinal construction joints shall be bonded in drilled holes.

(3) Placing dowels and tie bars. Horizontal spacing of dowels shall be within a tolerance of ±3/4 inch (19 mm). The vertical location on the face of the slab shall be within a tolerance of ±1/2 inch (12 mm). The method used to install dowels shall ensure that the horizontal and vertical alignment will not be greater than 1/4 inch per feet (6 mm per 0.3 m), except for those across the crown or other grade change joints. Dowels across crowns and other joints at grade changes shall be measured to a level surface. Horizontal alignment shall be checked perpendicular to the joint edge. The portion of each dowel intended to move within the concrete or expansion cap shall be wiped clean and coated with a thin, even film of lubricating oil or light grease before the concrete is placed. Dowels shall be installed as specified in the following subparagraphs.

(a) Contraction joints. Dowels and tie bars in longitudinal and transverse contraction joints within the paving lane shall be held securely in place by means of rigid metal frames or basket assemblies of an approved type. The basket assemblies shall be held securely in the proper location by means of suitable pins or anchors. Do not cut or crimp the dowel basket tie wires.

At the Contractor's option, dowels and tie bars in contraction joints may be installed by insertion into the plastic concrete using approved equipment and procedures per the paver manufacturer's design. Approval of installation methods will be based on the results of the control strip showing that the dowels and tie bars are installed within specified tolerances as verified by cores or non-destructive rebar location devices approved by the RPR.

(b) Construction joints. Install dowels and tie bars by the cast-in- place or the drill-and-dowel method. Installation by removing and replacing in preformed holes will not be permitted. Dowels and tie bars shall be prepared and placed across joints where indicated, correctly aligned, and securely held in the proper horizontal and vertical position during placing and finishing operations, by means of devices fastened to the forms.

(c) Joints in hardened concrete. Install dowels in hardened concrete by bonding the dowels into holes drilled into the concrete. The concrete shall have cured for seven (7) days or reached a minimum compressive strength of 3100 psi (21.4 MPa) before drilling begins. Holes 1/8 inch (3 mm) greater in diameter than the dowels shall be drilled into the hardened concrete using rotary-core drills. Rotary-percussion drills may be used, provided that excessive spalling does not occur. Spalling beyond the limits of the grout retention ring will require modification of the equipment and operation. Depth of dowel hole shall be within a tolerance of ±1/2 inch (12 mm) of the dimension shown on the drawings. On completion of the drilling operation, the dowel hole shall be blown out with oil-free, compressed air. Dowels shall be bonded in the drilled holes using epoxy resin. Epoxy resin shall be injected at the back of the hole before installing the dowel and extruded to the collar during insertion of the dowel so as to completely fill the void around the dowel. Application by buttering the dowel will not be permitted. The dowels shall be held in alignment at the collar of the hole by means of a suitable metal or plastic grout retention ring fitted around the dowel.

e. Sawing of joints. Sawing shall commence, without regard to day or night, as soon as the concrete has hardened sufficiently to permit cutting without chipping, spalling, or tearing and before uncontrolled shrinkage cracking of the pavement occurs and shall continue without interruption until all joints have been sawn. All slurry and debris produced in the sawing of joints shall be removed by vacuuming and washing. Curing compound or system shall be reapplied in the initial saw-cut and maintained for the remaining cure period.

Joints shall be cut in locations as shown on the plans. The initial joint cut shall be a minimum 1/8 inch (3 mm) wide and to the depth shown on the plans. Prior to placement of joint sealant or seals, the top of the joint shall be widened by sawing as shown on the plans.

501-4.11 Finishing. Finishing operations shall be a continuing part of placing operations starting immediately behind the strike-off of the paver. Initial finishing shall be provided by the transverse screed or extrusion plate. The sequence of operations shall be transverse finishing, longitudinal machine floating if used, straightedge finishing, edging of joints, and then texturing. Finishing shall be by the machine method. The hand method shall be used only on isolated areas of odd slab widths or shapes and in the event of a breakdown of the mechanical finishing equipment. Supplemental hand finishing for machine finished pavement shall be kept to an absolute minimum. Any machine finishing operation which requires appreciable hand finishing, other than a moderate amount of straightedge finishing, shall be immediately stopped and proper adjustments made or the equipment replaced. Equipment, mixture, and/or procedures which produce more than 1/4 inch (6 mm) of mortar-rich surface shall be immediately modified as necessary to eliminate this condition or operations shall cease. Compensation shall be made for surging behind the screeds or extrusion plate and settlement during hardening and care shall be taken to ensure that paving and finishing machines are properly adjusted so that the finished surface of the concrete (not just the cutting edges of the screeds) will be at the required line and grade. Finishing equipment and tools shall be maintained clean and in an approved condition. At no time shall water be added to the surface of the slab with the finishing equipment or tools, or in any other way. Fog (mist) sprays or other surface applied finishing aids specified to prevent plastic shrinkage cracking, approved by the RPR, may be used in accordance with the manufacturers requirements.

a. Machine finishing with slipform pavers. The slipform paver shall be operated so that only a very minimum of additional finishing work is required to produce pavement surfaces and edges meeting the specified tolerances. Any equipment or procedure that fails to meet these specified requirements shall immediately be replaced or modified as necessary. A self-propelled non-rotating pipe float may be used while the concrete is still plastic, to remove minor irregularities and score marks. Only one pass of the pipe float shall be allowed. Equipment, mixture, and/or procedures which produce more than 1/4 inch (6 mm) of mortar-rich surface shall be immediately modified as necessary to eliminate this condition or operations shall cease. Remove excessive slurry from the surface with a cutting straightedge and wipe off the edge. Any slurry which does run down the vertical edges shall be immediately removed by hand, using stiff brushes or scrapers. No slurry, concrete or concrete mortar shall be used to build up along the edges of the pavement to compensate for excessive edge slump, either while the concrete is plastic or after it hardens.

b. Machine finishing with fixed forms. The machine shall be designed to straddle the forms and shall be operated to screed and consolidate the concrete. Machines that cause displacement of the forms shall be replaced. The machine shall make only one pass over each area of pavement. If the equipment and procedures do not produce a surface of uniform texture, true to grade, in one pass, the operation shall be immediately stopped and the equipment, mixture, and procedures adjusted as necessary.

c. Other types of finishing equipment. Clary screeds, other rotating tube floats, or bridge deck finishers are not allowed on mainline paving, but may be allowed on irregular or odd-shaped slabs, and near buildings or trench drains, subject to the RPR's approval.

Bridge deck finishers shall have a minimum operating weight of 7500 pounds (3400 kg) and shall have a transversely operating carriage containing a knock-down auger and a minimum of two immersion vibrators. Vibrating screeds or pans shall be used only for isolated slabs where hand finishing is permitted as specified, and only where specifically approved.

d. Hand finishing. Hand finishing methods will not be permitted, except under the following conditions: (1) in the event of breakdown of the mechanical equipment, hand methods may be used to

finish the concrete already deposited on the grade and (2) in areas of narrow widths or of irregular dimensions where operation of the mechanical equipment is impractical.

e. Straightedge testing and surface correction. After the pavement has been struck off and while the concrete is still plastic, it shall be tested for trueness with a 12-foot (3.7-m) finishing straightedge swung from handles capable of spanning at least one-half the width of the slab. The straightedge shall be held in contact with the surface in successive positions parallel to the centerline and the whole area gone over from one side of the slab to the other, as necessary. Advancing shall be in successive stages of not more than one-half the length of the straightedge. Any excess water and laitance in excess of 1/8 inch (3 mm) thick shall be removed from the surface of the pavement and wasted. Any depressions shall be immediately filled with freshly mixed concrete, struck off, consolidated, and refinished. High areas shall be cut down and refinished. Special attention shall be given to assure that the surface across joints meets the smoothness requirements. Straightedge testing and surface corrections shall continue until the entire surface is found to be free from observable departures from the straightedge and until the slab conforms to the required grade and cross-section. The use of long-handled wood floats shall be confined to a minimum; they may be used only in emergencies and in areas not accessible to finishing equipment.

501-4.12 Surface texture. The surface of the pavement shall be finished as designated below for all newly constructed concrete pavements. It is important that the texturing equipment not tear or unduly roughen the pavement surface during the operation. The texture shall be uniform in appearance and approximately 1/16 inch (2 mm) in depth. Any imperfections resulting from the texturing operation shall be corrected to the satisfaction of the RPR.

a. Brush or broom finish. Shall be applied when the water sheen has practically disappeared. The equipment shall operate transversely across the pavement surface.

b. Burlap drag finish. Not used.

c. Artificial turf finish. Not used.

501-4.13 Curing. Immediately after finishing operations are completed and bleed water is gone from the surface, all exposed surfaces of the newly placed concrete shall be cured for a 7-day cure period in accordance with one of the methods below. Failure to provide sufficient cover material of whatever kind the Contractor may elect to use, or lack of water to adequately take care of both curing and other requirements, shall be cause for immediate suspension of concreting operations. The concrete shall not be left exposed for more than 1/2 hour during the curing period.

When a two-saw-cut method is used to construct the contraction joint, the curing compound shall be applied to the saw-cut immediately after the initial cut has been made. The sealant reservoir shall not be sawed until after the curing period has been completed. When the one cut method is used to construct the contraction joint, the joint shall be cured with wet rope, wet rags, or wet blankets. The rags, ropes, or blankets shall be kept moist for the duration of the curing period.

a. Impervious membrane method. Curing with liquid membrane compounds should not occur until bleed and surface moisture has evaporated. All exposed surfaces of the pavement shall be sprayed uniformly with white pigmented curing compound immediately after the finishing of the surface and before the set of the concrete has taken place. The curing compound shall not be applied during rainfall. Curing compound shall be applied by mechanical sprayers under pressure at the rate of one gallon (4 liters) to not more than 150 square feet (14 sq m). The spraying equipment shall be of the fully atomizing type equipped with a tank agitator. At the time of use, the compound shall be in a thoroughly mixed condition with the pigment uniformly dispersed throughout the vehicle. During application, the compound shall be stirred continuously by mechanical means. Hand spraying of odd widths or shapes and concrete surfaces exposed by the removal of forms will be permitted. When hand spraying is approved by the RPR, a double application rate shall be used to ensure coverage. Should the film become damaged from any cause, including sawing operations, within the required curing period, the damaged portions

shall be repaired immediately with additional compound or other approved means. Upon removal of side forms, the sides of the exposed slabs shall be protected immediately to provide a curing treatment equal to that provided for the surface.

b. White burlap-polyethylene sheets. The surface of the pavement shall be entirely covered with the sheeting. The sheeting used shall be such length (or width) that it will extend at least twice the thickness of the pavement beyond the edges of the slab. The sheeting shall be placed so that the entire surface and both edges of the slab are completely covered. The sheeting shall be placed and weighted to remain in contact with the surface covered, and the covering shall be maintained fully saturated and in position for seven (7) days after the concrete has been placed.

c. Water method. The entire area shall be covered with burlap or other water absorbing material. The material shall be of sufficient thickness to retain water for adequate curing without excessive runoff. The material shall be kept wet at all times and maintained for seven (7) days. When the forms are stripped, the vertical walls shall also be kept moist. It shall be the responsibility of the Contractor to prevent ponding of the curing water on the subbase.

d. Concrete protection for cold weather. Maintain the concrete at a temperature of at least 50°F (10°C) for a period of 72 hours after placing and at a temperature above freezing for the remainder of the 7-day curing period. The Contractor shall be responsible for the quality and strength of the concrete placed during cold weather; and any concrete damaged shall be removed and replaced at the Contractor's expense.

e. Concrete protection for hot weather. Concrete should be continuous moisture cured for the entire curing period and shall commence as soon as the surfaces are finished and continue for at least 24 hours. However, if moisture curing is not practical beyond 24 hours, the concrete surface shall be protected from drying with application of a liquid membrane-forming curing compound while the surfaces are still damp. Other curing methods may be approved by the RPR.

501-4.14 Removing forms. Unless otherwise specified, forms shall not be removed from freshly placed concrete until it has hardened sufficiently to permit removal without chipping, spalling, or tearing. After the forms have been removed, the sides of the slab shall be cured in accordance with paragraph 501-4.13.

If honeycombed areas are evident when the forms are removed, materials, placement, and consolidation methods must be reviewed and appropriate adjustments made to assure adequate consolidation at the edges of future concrete placements. Honeycombed areas that extend into the slab less than approximately 1 inch (25 mm), shall be repaired with an approved grout, as directed by the RPR. Honeycombed areas that extend into the slab greater than a depth of 1 inch (25 mm) shall be considered as defective work and shall be removed and replaced in accordance with paragraph 501-4.19.

501-4.15 Saw-cut grooving. If shown on the plans, grooved surfaces shall be provided in accordance with the requirements of Item P-621.

501-4.16 Sealing joints. The joints in the pavement shall be sealed in accordance with Item P-605.

501-4.17 Protection of pavement. The Contractor shall protect the pavement and its appurtenances against both public traffic and traffic caused by the Contractor's employees and agents until accepted by the RPR. This shall include watchmen to direct traffic and the erection and maintenance of warning signs, lights, pavement bridges, crossovers, and protection of unsealed joints from intrusion of foreign material, etc. Any damage to the pavement occurring prior to final acceptance shall be repaired or the pavement replaced at the Contractor's expense.

Aggregates, rubble, or other similar construction materials shall not be placed on airfield pavements. Traffic shall be excluded from the new pavement by erecting and maintaining barricades and signs until the concrete is at least seven (7) days old, or for a longer period if directed by the RPR.

In paving intermediate lanes between newly paved pilot lanes, operation of the hauling and paving equipment will be permitted on the new pavement after the pavement has been cured for seven (7) days, the joints are protected, the concrete has attained a minimum field cured flexural strength of [450 psi (3100 kPa)], and the slab edge is protected.

All new and existing pavement carrying construction traffic or equipment shall be kept clean and spillage of concrete and other materials shall be cleaned up immediately.

Damaged pavements shall be removed and replaced at the Contractor's expense. Slabs shall be removed to the full depth, width, and length of the slab.

501-4.18 Opening to construction traffic. The pavement shall not be opened to traffic until test specimens molded and cured in accordance with ASTM C31 have attained a flexural strength of [450 pounds per square inch (3100 kPa)] when tested in accordance with ASTM C78. If such tests are not conducted, the pavement shall not be opened to traffic until 14 days after the concrete was placed. Prior to opening the pavement to construction traffic, all joints shall either be sealed or protected from damage to the joint edge and intrusion of foreign materials into the joint. As a minimum, backer rod or tape may be used to protect the joints from foreign matter intrusion.

501-4.19 Repair, removal, or replacement of slabs. New pavement slabs that are broken or contain cracks or are otherwise defective or unacceptable as defined by acceptance criteria in paragraph 501-6.6 shall be removed and replaced or repaired, as directed by the RPR, at the Contractor's expense. Spalls along joints shall be repaired as specified. Removal of partial slabs is not permitted. Removal and replacement shall be full depth, shall be full width of the slab, and the limit of removal shall be normal to the paving lane and to each original transverse joint. The RPR will determine whether cracks extend full depth of the pavement and may require cores to be drilled on the crack to determine depth of cracking. Such cores shall be have a diameter of 2 inches (50 mm) to 4 inches (100 mm), shall be drilled by the Contractor and shall be filled by the Contractor with a well consolidated concrete mixture bonded to the walls of the hole with a bonding agent, using approved procedures. Drilling of cores and refilling holes shall be at no expense to the Owner. Repair of cracks as described in this section shall not be allowed if in the opinion of the RPR the overall condition of the pavement indicates that such repair is unlikely to achieve an acceptable and durable finished pavement. No repair of cracks shall be allowed in any panel that demonstrates segregated aggregate with an absence of coarse aggregate in the upper 1/8 inch (3 mm) of the pavement surface.

a. Shrinkage cracks. Shrinkage cracks which do not exceed one-third of the pavement depth shall be cleaned and either high molecular weight methacrylate (HMWM) applied; or epoxy resin (Type IV, Grade 1) pressure injected using procedures recommended by the manufacturer and approved by the RPR. Sandblasting of the surface may be required following the application of HMWM to restore skid resistance. Care shall be taken to ensure that the crack is not widened during epoxy resin injection. All epoxy resin injection shall take place in the presence of the RPR. Shrinkage cracks which exceed one-third the pavement depth shall be treated as full depth cracks in accordance with paragraphs 501-4.19b and 501-19c.

b. Slabs with cracks through interior areas. Interior area is defined as that area more than 6 inches (150 mm) from either adjacent original transverse joint. The full slab shall be removed and replaced at no cost to the Owner, when there are any full depth cracks, or cracks greater than one-third the pavement depth, that extend into the interior area.

c. Cracks close to and parallel to joints. All full-depth cracks within 6 inches (150 mm) either side of the joint and essentially parallel to the original joints, shall be treated as follows.

(1) Full depth cracks and original joint not cracked. The full-depth crack shall be treated as the new joint and the original joint filled with an epoxy resin.

i. Full-depth crack. The joint sealant reservoir for the crack shall be formed by sawing to a depth of 3/4 inches (19 mm), ±1/16 inch (2 mm), and to a width of 5/8 inch (16 mm), ±1/8 inch (3 mm). The crack shall be sawed with equipment specially designed to follow random cracks. Any equipment or procedure which causes raveling or spalling along the crack shall be modified or replaced to prevent raveling or spalling. The joint shall be sealed with sealant in accordance with P-605 or as directed by the RPR.

ii. Original joint. If the original joint sealant reservoir has been sawed out, the reservoir and as much of the lower saw cut as possible shall be filled with epoxy resin, Type IV, Grade 2, thoroughly tooled into the void using approved procedures.

If only the original narrow saw cut has been made, it shall be cleaned and pressure injected with epoxy resin, Type IV, Grade 1, using approved procedures.

Where a parallel crack goes part way across paving lane and then intersects and follows the original joint which is cracked only for the remained of the width, it shall be treated as specified above for a parallel crack, and the cracked original joint shall be prepared and sealed as originally designed.

(2) Full depth cracks and original joint cracked. If there is any place in the lane width where a parallel crack and a cracked portion of the original joint overlap, the entire slab containing the crack shall be removed and replaced.

d. Removal and replacement of full slabs. Make a full depth cut perpendicular to the slab surface along all edges of the slab with a concrete saw cutting any dowels or tie-bars. Remove damaged slab protecting adjacent pavement from damage. Damage to adjacent slabs may result in removal of additional slabs as directed by the RPR at the Contractor's expense.

The underlying material shall be repaired, re-compacted and shaped to grade.

Dowels of the size and spacing specified for other joints in similar pavement on the project shall be installed along all four (4) edges of the new slab in accordance with paragraph 501-4.10d.

Placement of concrete shall be as specified for original construction. The joints around the new slab shall be prepared and sealed as specified for original construction.

e. Spalls along joints.

(1) Spalls less than one inch wide and less than the depth of the joint sealant reservoir, shall be filled with joint sealant material.

(2) Spalls larger than one inch and/or deeper than the joint reservoir, but less than ½ the slab depth, and less than 25% of the length of the adjacent joint shall be repaired as follows:

i. Make a vertical saw cut at least one inch (25 mm) outside the spalled area and to a depth of at least 2 inches (50 mm). Saw cuts shall be straight lines forming rectangular areas surrounding the spalled area.

ii. Remove unsound concrete and at least 1/2 inch (12 mm) of visually sound concrete between the saw cut and the joint or crack with a light chipping hammer.

iii. Clean cavity with high-pressure water jets supplemented with compressed air as needed to remove all loose material.

iv. Apply a prime coat of epoxy resin, Type III, Grade I, to the dry, cleaned surface of all sides and bottom of the cavity, except any joint face.

v. Fill the cavity with low slump concrete or mortar or with epoxy resin concrete or mortar.

vi. An insert or other bond-breaking medium shall be used to prevent bond at all joint faces.

vii. A reservoir for the joint sealant shall be sawed to the dimensions required for other joints, or as required to be routed for cracks. The reservoir shall be thoroughly cleaned and sealed with the sealer specified for the joints.

(3) Spalls deeper than 1/2 of the slab depth or spalls longer than 25% of the adjacent joint require replacement of the entire slab.

f. Diamond grinding of Concrete surfaces. Diamond grinding shall be completed prior to pavement grooving. Diamond grinding of the hardened concrete should not be performed until the concrete is at least 14 days old and has achieved full minimum strength. Equipment that causes ravels, aggregate fractures, spalls or disturbance to the joints will not be permitted. The depth of diamond grinding shall not exceed 1/2 inch (13 mm) and all areas in which diamond grinding has been performed will be subject to the final pavement thickness tolerances specified.

Diamond grinding shall be performed with a machine specifically designed for diamond grinding capable of cutting a path at least 3 feet (0.9 m) wide. The saw blades shall be 1/8-inch (3-mm) wide with sufficient number of flush cut blades that create grooves between 0.090 and 0.130 inches (2 and 3.5 mm) wide; and peaks and ridges approximately 1/32 inch (1 mm) higher than the bottom of the grinding cut. The Contractor shall determine the number and type of blades based on the hardness of the aggregate. Contractor shall demonstrate to the RPR that the grinding equipment will produce satisfactory results prior to making corrections to surfaces.

Grinding will be tapered in all directions to provide smooth transitions to areas not requiring grinding. The slurry resulting from the grinding operation shall be continuously removed and the pavement left in a clean condition. All grinding shall be at the expense of the Contractor.

CONTRACTOR QUALITY CONTROL (CQC)

501-5.1 Quality control program. The Contractor shall develop a Quality Control Program in accordance with Item C-100. No partial payment will be made for materials that are subject to specific quality control requirements without an approved quality control program.

501-5.2 Contractor Quality Control (CQC). The Contractor shall provide or contract for testing facilities in accordance with Item C-100. The RPR shall be permitted unrestricted access to inspect the Contractor's QC facilities and witness QC activities. The RPR will advise the Contractor in writing of any noted deficiencies concerning the QC facility, equipment, supplies, or testing personnel and procedures. When the deficiencies are serious enough to be adversely affecting the test results, the incorporation of the materials into the work shall be suspended immediately and will not be permitted to resume until the deficiencies are satisfactorily corrected.

501-5.3 Contractor QC testing. The Contractor shall perform all QC tests necessary to control the production and construction processes applicable to this specification and as set forth in the CQCP. The testing program shall include, but not necessarily be limited to, tests for aggregate gradation, aggregate moisture content, slump, and air content. A QC Testing Plan shall be developed and approved by the RPR as part of the CQCP.

The RPR may at any time, notwithstanding previous plant acceptance, reject and require the Contractor to dispose of any batch of concrete mixture which is rendered unfit for use due to contamination, segregation, or improper slump. Such rejection may be based on only visual inspection. In the event of such rejection, the Contractor may take a representative sample of the rejected material in the presence of the RPR, and if it can be demonstrated in the laboratory, in the presence of the RPR, that such material was erroneously rejected, payment will be made for the material at the contract unit price**.**

a. Fine aggregate.

(1) Gradation. A sieve analysis shall be made at least twice daily in accordance with ASTM C136 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.

(2) Moisture content. If an electric moisture meter is used, at least two direct measurements of moisture content shall be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests shall be made per day. Tests shall be made in accordance with ASTM C70 or ASTM C566.

(3) Deleterious substances. Fine aggregate as delivered to the mixer shall be tested for deleterious substances in fine aggregate for concrete as specified in paragraph 501-2.1b, prior to production of the control strip, and a minimum of every 30-days during production or more frequently as necessary to control deleterious substances.

b. Coarse Aggregate.

(1) Gradation. A sieve analysis shall be made at least twice daily for each size of aggregate. Tests shall be made in accordance with ASTM C136 from randomly sampled material taken from the discharge gate of storage bins or from the conveyor belt.

(2) Moisture content. If an electric moisture meter is used, at least two direct measurements of moisture content shall be made per week to check the calibration. If direct measurements are made in lieu of using an electric meter, two tests shall be made per day. Tests shall be made in accordance with ASTM C566.

(3) Deleterious substances. Coarse aggregate as delivered to the mixer shall be tested for deleterious substances in coarse aggregate for concrete as specified in paragraph 501-2.1c, prior to production of the control strip, and a minimum of every 30-days during production or more frequently as necessary to control deleterious substances.

c. Slump. One test shall be made for each sublot. Slump tests shall be performed in accordance with ASTM C143 from material randomly sampled from material discharged from trucks at the paving site. Material samples shall be taken in accordance with ASTM C172.

d. Air content. One test shall be made for each sublot. Air content tests shall be performed in accordance with ASTM C231 for gravel and stone coarse aggregate and ASTM C173 for slag or other porous coarse aggregate, from material randomly sampled from trucks at the paving site. Material samples shall be taken in accordance with ASTM C172.

e. Unit weight and Yield. One test shall be made for each sublot. Unit weight and yield tests shall be in accordance with ASTM C138. The samples shall be taken in accordance with ASTM C172 and at the same time as the air content tests.

f. Temperatures. Temperatures shall be checked at least four times per lot at the job site in accordance with ASTM C1064.

g. Smoothness for Contractor Quality Control.

The Contractor shall perform smoothness testing in transverse and longitudinal directions daily to verify that the construction processes are producing pavement with variances less than ¼ inch in 12 feet, identifying areas that may pond water which could lead to hydroplaning of aircraft. If the smoothness criteria is not met, appropriate changes and corrections to the construction process shall be made by the Contractor before construction continues

The Contractor may use a 12-foot (3.7 m) “straightedge, a rolling inclinometer meeting the requirements of ASTM E2133 or rolling external reference device that can simulate a 12-foot (3.7m) straightedge approved by the RPR. Straight-edge testing shall start with one-half the length of the straightedge at the edge of pavement section being tested and then moved ahead one-half the length of the straightedge for each successive measurement. Testing shall be continuous across all joints. The surface irregularity shall be determined by placing the freestanding (unleveled) straightedge on the pavement surface and allowing it to rest upon the two highest spots covered by its length, and measuring the maximum gap between the straightedge and the pavement surface in the area between the two high

points. If the rolling inclinometer or external reference device is used, the data may be evaluated using either the FAA profile program, ProFAA, or FHWA profile program ProVal, using the 12-foot straightedge simulation function.

Smoothness readings shall not be made across grade changes or cross slope transitions. The transition between new and existing pavement shall be evaluated separately for conformance with the plans.

(1) Transverse measurements. Transverse measurements shall be taken for each day's production placed. Transverse measurements shall be taken perpendicular to the pavement centerline each 50 feet (15 m) or more often as determined by the RPR. The joint between lanes shall be tested separately to facilitate smoothness between lanes.

(2) Longitudinal measurements. Longitudinal measurements shall be taken for each day's production placed. Longitudinal tests shall be parallel to the centerline of paving; at the center of paving lanes when widths of paving lanes are less than 20 feet (6 m); and at the third points of paving lanes when widths of paving lanes are 20 ft (6 m) or greater. When placement abuts previously placed material the first measurement shall start with one half the length of the straight edge on the previously placed material.

Deviations on the final surface course in either the transverse or longitudinal direction that will trap water greater than 1/4 inch (6 mm) shall be corrected with diamond grinding per paragraph 501-4.19f or by removing and replacing the surface course to full depth. Grinding shall be tapered in all directions to provide smooth transitions to areas not requiring grinding. All areas in which diamond grinding has been performed shall be subject to the final pavement thickness tolerances specified in paragraph 501-6.6.

Control charts shall be kept to show area of each day's placement and the percentage of corrective grinding required. Corrections to production and placement shall be initiated when corrective grinding is required. If the Contractor's machines and/or methods produce significant areas that need corrective actions in excess of 10 percent of a day's production, production shall be stopped until corrective measures are implemented by the Contractor.

h. Grade. Grade will be evaluated prior to and after placement of the concrete surface.

Measurements will be taken at appropriate gradelines (as a minimum at center and edges of paving lane) and longitudinal spacing as shown on cross-sections and plans. The final surface of the pavement will not vary from the gradeline elevations and cross-sections shown on the plans by more than 1/2 inch (12 mm) vertically and 0.1 feet (30 mm) laterally. The documentation will be provided by the Contractor to the RPR by the end of the following working day.

Areas with humps or depression that that exceed grade or smoothness and that retain water on the surface must be ground off provided the course thickness after grinding is not more than 1/2 inch (12 mm) less than the thickness specified on the plans. If these areas cannot be corrected with grinding then the slabs that are retaining water must be removed and replaced in accordance with paragraph 501-4.19d. Grinding shall be in accordance with paragraph 501-4.19f. All corrections will be at the Contractors expense.

501-5.4 Control charts. The Contractor shall maintain linear control charts for fine and coarse aggregate gradation, slump, and air content. The Contractor shall also maintain a control chart plotting the coarseness factor/workability factor from the combined gradations in accordance with paragraph 501-2.1d.

Control charts shall be posted in a location satisfactory to the RPR and shall be kept up to date at all times. As a minimum, the control charts shall identify the project number, the contract item number, the test number, each test parameter, the Action and suspension Limits, or Specification limits, applicable to each test parameter, and the Contractor's test results. The Contractor shall use the control charts as part of a process control system for identifying potential problems and assignable causes before they occur. If the

Contractor's projected data during production indicates a potential problem and the Contractor is not taking satisfactory corrective action, the RPR may halt production or acceptance of the material.

a. Fine and coarse aggregate gradation. The Contractor shall record the running average of the last five gradation tests for each control sieve on linear control charts. Superimposed on the control charts shall be the action and suspension limits. Gradation tests shall be performed by the Contractor per ASTM C136. The Contractor shall take at least **[** two **]** samples per lot to check the final gradation. Sampling shall be per ASTM D75 from the flowing aggregate stream or conveyor belt.

b. Slump and air content. The Contractor shall maintain linear control charts both for individual measurements and range (that is, difference between highest and lowest measurements) for slump and air content in accordance with the following Action and Suspension Limits.

c. Combined gradation. The Contractor shall maintain a control chart plotting the coarseness factor and workability factor on a chart in accordance with paragraph 501-2.1d.

Control Chart Limits[1]

Control Parameter	Individual Measurements	
	Action Limit	**Suspension Limit**
Gradation[2]	*[3]	*[3]
Coarseness Factor (CF)	±3.5	±5
Workability Factor (WF)	±2	±3
Slump	+0.5 to -1 inch (+13 to -25 mm)	+1 to -1.5 inch (+25 to -38 mm)
Air Content	±1.5%	±2.0%

[1] Control charts shall developed and maintained for each control parameter indicated.

[2] Control charts shall be developed and maintained for each sieve size.

[3] Action and suspension limits shall be determined by the Contractor.

501-5.5 Corrective action at Suspension Limit. The CQCP shall indicate that appropriate action shall be taken when the process is believed to be out of control. The CQCP shall detail what action will be taken to bring the process into control and shall contain sets of rules to gauge when a process is out of control. As a minimum, a process shall be deemed out of control and corrective action taken if any one of the following conditions exists.

a. Fine and coarse aggregate gradation. When two consecutive averages of five tests are outside of the suspension limits, immediate steps, including a halt to production, shall be taken to correct the grading.

b. Coarseness and Workability factor. When the CF or WF reaches the applicable suspension limits, the Contractor, immediate steps, including a halt to production, shall be taken to correct the CF and WF.

c. Fine and coarse aggregate moisture content. Whenever the moisture content of the fine or coarse aggregate changes by more than 0.5%, the scale settings for the aggregate batcher and water batcher shall be adjusted.

d. Slump. The Contractor shall halt production and make appropriate adjustments whenever:

(1) one point falls outside the Suspension Limit line for individual measurements

OR

(2) two points in a row fall outside the Action Limit line for individual measurements.

d. Air content. The Contractor shall halt production and adjust the amount of air-entraining admixture whenever:

(1) one point falls outside the Suspension Limit line for individual measurements

OR

(2) two points in a row fall outside the Action Limit line for individual measurements.

MATERIAL ACCEPTANCE

501-6.1 Quality Assurance (QA) Acceptance sampling and testing. All acceptance sampling and testing necessary to determine conformance with the requirements specified in this section, with the exception of coring for thickness determination, will be performed by the RPR. The Contractor shall provide adequate facilities for the initial curing of beams. The Contractor shall bear the cost of providing initial curing facilities and coring and filling operations, per paragraph 501-6.5b(1).

The samples will be transported while in the molds. The curing, except for the initial cure period, will be accomplished using the immersion in saturated lime water method. During the 24 hours after molding, the temperature immediately adjacent to the specimens must be maintained in the range of 60° to 80°F (16° to 27°C), and loss of moisture from the specimens must be prevented. The specimens may be stored in tightly constructed wooden boxes, damp sand pits, temporary buildings at construction sites, under wet burlap in favorable weather, or in heavyweight closed plastic bags, or using other suitable methods, provided the temperature and moisture loss requirements are met.

501-6.2 Quality Assurance (QA) testing laboratory. Quality assurance testing organizations performing these acceptance tests will be accredited in accordance with ASTM C1077. The quality assurance laboratory accreditation must be current and listed on the accrediting authority's website. All test methods required for acceptance sampling and testing must be listed on the lab accreditation. A copy of the laboratory's current accreditation and accredited test methods will be submitted to the RPR prior to start of construction.

501-6.3 Lot size. Concrete will be accepted for strength and thickness on a lot basis. A lot will consist of a day's production not to exceed 2,000 cubic yards (1530 cubic meters). Each lot will be divided into approximately equal sublots with individual sublots between 400 to 600 cubic yards. Where three sublots are produced, they will constitute a lot. Where one or two sublots are produced, they will be incorporated into the previous or next lot. Where more than one plant is simultaneously producing concrete for the job, the lot sizes will apply separately for each plant.

501-6.4 Partial lots. When operational conditions cause a lot to be terminated before the specified number of tests have been made for the lot or for overages or minor placements to be considered as partial lots, the following procedure will be used to adjust the lot size and the number of tests for the lot.

Where three sublots have been produced, they will constitute a lot. Where one or two sublots have been produced, they will be incorporated into the next lot or the previous lot and the total number of sublots will be used in the acceptance criteria calculation, that is, n=5 or n=6.

501-6.5 Acceptance Sampling and Testing.

a. Strength.

(1) Sampling. One sample will be taken for each sublot from the concrete delivered to the job site. Sampling locations will be determined by the RPR in accordance with random sampling procedures contained in ASTM D3665. The concrete will be sampled in accordance with ASTM C172.

(2) Test Specimens. The RPR will be responsible for the casting, initial curing, transportation, and curing of specimens in accordance with ASTM C31. Two (2) specimens will be made from each sample and slump, air content, unit weight, and temperature tests will be conducted for each set of strength specimens. Within 24 to 48 hours, the samples will be transported from the field to the laboratory while in the molds. Samples will be cured in saturated lime water.

The strength of each specimen will be determined in accordance with ASTM C39. The strength for each sublot will be computed by averaging the results of the two test specimens representing that sublot.

(3) Acceptance. Acceptance of pavement for strength will be determined by the RPR in accordance with paragraph 501-6.6b(1). All individual strength tests within a lot will be checked for outliers in accordance with ASTM E178, at a significance level of 5%. Outliers will be discarded and the remaining test values will be used to determine acceptance in accordance with paragraph 501-6.5b.

b. Pavement thickness.

(1) Sampling. One core will be taken by the Contractor for each sublot in the presence of the RPR. Sampling locations will be determined by the RPR in accordance with random sampling procedures contained in ASTM D3665. Areas, such as thickened edges, with planned variable thickness, will be excluded from sample locations.

Cores shall be a minimum 4 inch (100 mm) in diameter neatly cut with a core drill. The Contractor will furnish all tools, labor, and materials for cutting samples and filling the cored hole. Core holes will be filled by the Contractor with a non-shrink grout approved by the RPR within one day after sampling.

(2) Testing. The thickness of the cores will be determined by the RPR by the average caliper measurement in accordance with ASTM C174. Each core shall be photographed and the photograph included with the test report.

(3) Acceptance. Acceptance of pavement for thickness will be determined by the RPR in accordance with paragraph 501-6.6.

501-6.6 Acceptance criteria.

a. General. Acceptance will be based on the following characteristics of the completed pavement discussed in paragraph 501-6.5b:

(1) Strength

(2) Thickness

(3) Grade

(4) Profilograph smoothness - Not used.

(5) Adjustments for repairs

Acceptance for strength, thickness, and grade, will be based on the criteria contained in accordance with paragraph 501-6.6b(1), 501-6.6b(2), and 501-6.6b(3), respectively.

(3) Grade. The final finished surface of the pavement of the completed project will not vary from the gradeline elevations and cross-sections shown on the plans by more than 1/2 inch (12 mm) vertically 0.1 feet (30 mm) laterally. The documentation, stamped and signed by a licensed surveyor shall be in accordance with paragraph 501-5.3h. Payment for sublots that do not meet grade for over 25% of the sublot shall reduced by 5% and not be more than 95%.

(4) Profilograph roughness for QA Acceptance. Not used.

(5) Adjustments for repair. Sublots with spall repairs, crack repairs, or partial panel replacement, will be limited to no more than 95% payment.

(6) Adjustment for grinding. For sublots with grinding over 25% of a sublot, payment will be reduced 5%.

METHOD OF MEASUREMENT

501-7.1 Cement Concrete Pavement shall be measured based on the percentage of work completed as determined by the RPR.

BASIS OF PAYMENT

501-8.1 Payment. Cement Concrete Pavement shall be paid for as a percentage of the contract lump sum based on the work completed as determined by the RPR.

Payment will be made under:

Item P-501 Cement Concrete Pavement

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM A184	Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A704	Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement
ASTM A706	Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A775	Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A884	Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
ASTM A934	Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars
ASTM A996	Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement
ASTM A1035	Standard Specification for Deformed and Plain, Low-Carbon, Chromium, Steel Bars for Concrete Reinforcement
ASTM A1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM A1078	Standard Specification for Epoxy-Coated Steel Dowels for Concrete Pavement

ASTM C29	Standard Test Method for Bulk Density (“Unit Weight”) and Voids in Aggregate
ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C70	Standard Test Method for Surface Moisture in Fine Aggregate
ASTM C78	Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading)
ASTM C88	Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C114	Standard Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C117	Standard Test Method for Materials Finer than 75-µm (No. 200) Sieve in Mineral Aggregates by Washing
ASTM C123	Standard Test Method for Lightweight Particles in Aggregate
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C131	Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C138	Standard Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete
ASTM C142	Standard Test Method for Clay Lumps and Friable Particles in Aggregates
ASTM C143	Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C173	Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
ASTM C174	Standard Test Method for Measuring Thickness of Concrete Elements Using Drilled Concrete Cores
ASTM C227	Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method)
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete

ASTM C295	Standard Guide for Petrographic Examination of Aggregates for Concrete
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C311	Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland Cement Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C566	Standard Test Method for Total Evaporable Moisture Content of Aggregates by Drying
ASTM C595	Standard Specification for Blended Hydraulic Cements
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C642	Standard Test Method for Density, Absorption, and Voids in Hardened Concrete
ASTM C666	Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
ASTM C685	Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C881	Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete
ASTM C989	Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1017	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1064	Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1157	Standard Performance Specification for Hydraulic Cement
ASTM C1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)
ASTM C1365	Standard Test Method for Determination of the Proportion of Phases in Portland Cement and Portland-Cement Clinker Using X-Ray Powder Diffraction Analysis
ASTM C1567	Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method)
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D75	Standard Practice for Sampling Aggregates

ASTM D1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types)
ASTM D1752	Standard Specification for Preformed Sponge Rubber and Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction
ASTM D2419	Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregate
ASTM D3665	Standard Practice for Random Sampling of Construction Materials
ASTM D4791	Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate
ASTM E178	Standard Practice for Dealing with Outlying Observations
ASTM E1274	Standard Test Method for Measuring Pavement Roughness Using a Profilograph
ASTM E2133	Standard Test Method for Using a Rolling Inclinometer to Measure Longitudinal and Transverse Profiles of a Traveled Surface

American Concrete Institute (ACI)

ACI 305R	Guide to Hot Weather Concreting
ACI 306R	Guide to Cold Weather Concreting
ACI 309R	Guide for Consolidation of Concrete

Advisory Circulars (AC)

AC 150/5320-6	Airport Pavement Design and Evaluation

Federal Highway Administration (FHWA)

HIPERPAV 3, version 3.2

Portland Concrete Association (PCA)

PCA	Design and Control of Concrete Mixtures, 16th Edition

U.S. Army Corps of Engineers (USACE) Concrete Research Division (CRD)

CRD C662	Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials, Lithium Nitrate Admixture and Aggregate (Accelerated Mortar-Bar Method)

United States Air Force Engineering Technical Letter (ETL)

ETL 97-5	Proportioning Concrete Mixtures with Graded Aggregates for Rigid Airfield Pavements

END ITEM P-501

Part 8 – Surface Treatments [NOT USED]

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Part 9 – Miscellaneous

Item P-603 Emulsified Asphalt Tack Coat

DESCRIPTION

603-1.1 This item shall consist of preparing and treating an asphalt or concrete surface with asphalt material in accordance with these specifications and in reasonably close conformity to the lines shown on the plans.

MATERIALS

603-2.1 Asphalt materials. The asphalt material shall be an emulsified asphalt as specified in ASTM D3628 as an asphalt application for tack coat appropriate to local conditions. The emulsified asphalt shall not be diluted. The Contractor shall provide a copy of the manufacturer's Certificate of Analysis (COA) for the asphalt material to the Resident Project Representative (RPR) before the asphalt material is applied for review and acceptance. The furnishing of COA for the asphalt material shall not be interpreted as a basis for final acceptance. The manufacturer's COA may be subject to verification by testing the material delivered for use on the project.

CONSTRUCTION METHODS

603-3.1 Weather limitations. The tack coat shall be applied only when the existing surface is dry and the atmospheric temperature is 50°F (10°C) or above; the temperature has not been below 35°F (2°C) for the 12 hours prior to application; and when the weather is not foggy or rainy. The temperature requirements may be waived when directed by the RPR.

603-3.2 Equipment. The Contractor shall provide equipment for heating and applying the emulsified asphalt material. The emulsion shall be applied with a manufacturer-approved computer rate-controlled asphalt distributor. The equipment shall be in good working order and contain no contaminants or diluents in the tank. Spray bar tips must be clean, free of burrs, and of a size to maintain an even distribution of the emulsion. Any type of tip or pressure source is suitable that will maintain predetermined flow rates and constant pressure during the application process with application speeds under eight (8) miles per hour (13 km per hour) or seven (700) feet per minute (213 m per minute).

The equipment will be tested under pressure for leaks and to ensure proper set-up before use to verify truck set-up (via a test-shot area), including but not limited to, nozzle tip size appropriate for application, spray-bar height and pressure and pump speed, evidence of triple-overlap spray pattern, lack of leaks, and any other factors relevant to ensure the truck is in good working order before use.

The distributor truck shall be equipped with a minimum 12-foot (3.7-m) spreader spray bar with individual nozzle control with computer-controlled application rates. The distributor truck shall have an easily accessible thermometer that constantly monitors the temperature of the emulsion, and have an operable mechanical tank gauge that can be used to cross-check the computer accuracy. If the distributor is not equipped with an operable quick shutoff valve, the prime operations shall be started and stopped on building paper.

The distributor truck shall be equipped to effectively heat and mix the material to the required temperature prior to application as required. Heating and mixing shall be done in accordance with the manufacturer's recommendations. Do not overheat or over mix the material.

The distributor shall be equipped with a hand sprayer.

Asphalt distributors must be calibrated annually in accordance with ASTM D2995. The Contractor must furnish a current calibration certification for the asphalt distributor truck from any State or other agency as approved by the RPR.

A power broom and/or power blower suitable for cleaning the surfaces to which the asphalt tack coat is to be applied shall be provided.

603-3.3 Application of emulsified asphalt material. The emulsified asphalt shall not be diluted. Immediately before applying the emulsified asphalt tack coat, the full width of surface to be treated shall be swept with a power broom and/or power blower to remove all loose dirt and other objectionable material.

The emulsified asphalt material shall be uniformly applied with an asphalt distributor at the rates appropriate for the conditions and surface specified in the table below. The type of asphalt material and application rate shall be approved by the RPR prior to application.

Emulsified Asphalt

Surface Type	Residual Rate, gal/SY (L/square meter)	Emulsion Application Bar Rate, gal/SY (L/square meter)
New asphalt	0.02-0.05 (0.09-0.23)	0.03-0.07 (0.13-0.32)
Existing asphalt	0.04-0.07 (0.18-0.32)	0.06-0.11 (0.27-0.50)
Milled Surface	0.04-0.08 (0.18-0.36)	.0.06-0.12 (0.27-0.54)
Concrete	0.03-0.05 (0.13-0.23)	0.05-0.08 (0.23-0.36)

After application of the tack coat, the surface shall be allowed to cure without being disturbed for the period of time necessary to permit drying and setting of the tack coat. This period shall be determined by the RPR. The Contractor shall protect the tack coat and maintain the surface until the next course has been placed. When the tack coat has been disturbed by the Contractor, tack coat shall be reapplied at the Contractor's expense.

603-3.4 Freight and waybills The Contractor shall submit waybills and delivery tickets, during progress of the work. Before the final statement is allowed, file with the RPR certified waybills and certified delivery tickets for all emulsified asphalt materials used in the construction of the pavement covered by the contract. Do not remove emulsified asphalt material from storage until the initial outage and temperature measurements have been taken. The delivery or storage units will not be released until the final outage has been taken.

METHOD OF MEASUREMENT

603-4.1 Emulsified Asphalt Tack Coat shall be measured based on the percentage of work completed as determined by the RPR.

BASIS OF PAYMENT

603.42 Emulsified Asphalt Tack Coat shall be paid for as a percentage of the contract lump sum based on the work completed as determined by the RPR.

Payment will be made under:

Item P-603	Emulsified Asphalt Tack Coat

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM D1250	Standard Guide for Use of the Petroleum Measurement Tables
ASTM D2995	Standard Practice for Estimating Application Rate and Residual Application Rate of Bituminous Distributors
ASTM D3628	Standard Practice for Selection and Use of Emulsified Asphalts

END ITEM P-603

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Item P-605 Joint Sealants for Pavements

DESCRIPTION

605-1.1 This item shall consist of providing and installing a resilient and adhesive joint sealing material capable of effectively sealing joints in pavement; joints between different types of pavements; and cracks in existing pavement.

MATERIALS

605-2.1 Joint sealants. Joint sealant materials shall meet the requirements of ASTM C-920.

Each lot or batch of sealant shall be delivered to the jobsite in the manufacturer's original sealed container. Each container shall be marked with the manufacturer's name, batch or lot number, the safe heating temperature, and shall be accompanied by the manufacturer's certification stating that the sealant meets the requirements of this specification.

605-2.2 Backer rod. The material furnished shall be a compressible, non-shrinking, non-staining, non-absorbing material that is non-reactive with the joint sealant in accordance with ASTM D5249. The backer-rod material shall be 25% ± 5 % larger in diameter than the nominal width of the joint.

605-2.3 Bond breaking tapes. Provide a bond breaking tape or separating material that is a flexible, non-shrinkable, non-absorbing, non-staining, and non-reacting adhesive-backed tape. The material shall have a melting point at least 5°F (3°C) greater than the pouring temperature of the sealant being used when tested in accordance with ASTM D789. The bond breaker tape shall be approximately 1/8 inch (3 mm) wider than the nominal width of the joint and shall not bond to the joint sealant.

CONSTRUCTION METHODS

605-3.1 Time of application. Joints shall be sealed as soon after completion of the curing period as feasible and before the pavement is opened to traffic, including construction equipment. The pavement temperature shall be 50°F (10°C) and rising at the time of application of the poured joint sealing material. Do not apply sealant if moisture is observed in the joint.

605-3.2 Equipment. Machines, tools, and equipment used in the performance of the work required by this section shall be approved before the work is started and maintained in satisfactory condition at all times. Submit a list of proposed equipment to be used in performance of construction work including descriptive data, 30 days prior to use on the project.

a. Concrete saw. Provide a self-propelled power saw, with water-cooled diamond or abrasive saw blades, for cutting joints to the depths and widths specified.

b. Hand tools. Hand tools may be used, when approved, for removing defective sealant from a crack and repairing or cleaning the crack faces. Hand tools should be carefully evaluated for potential spalling effects prior to approval for use.

c. Hot-poured sealing equipment. The unit applicators used for heating and installing ASTM D6690 joint sealant materials shall be mobile and shall be equipped with a double-boiler, agitator-type kettle with

an oil medium in the outer space for heat transfer; a direct-connected pressure-type extruding device with a nozzle shaped for inserting in the joint to be filled; positive temperature devices for controlling the temperature of the transfer oil and sealant; and a recording type thermometer for indicating the temperature of the sealant. The applicator unit shall be designed so that the sealant will circulate through the delivery hose and return to the inner kettle when not in use.

d. Cold-applied, single-component sealing equipment. The equipment for installing ASTM D5893 single component joint sealants shall consist of an extrusion pump, air compressor, following plate, hoses, and nozzle for transferring the sealant from the storage container into the joint opening. The dimension of the nozzle shall be such that the tip of the nozzle will extend into the joint to allow sealing from the bottom of the joint to the top. Maintain the initially approved equipment in good working condition, serviced in accordance with the supplier's instructions, and unaltered in any way without obtaining prior approval. Small hand-held air-powered equipment (i.e., caulking guns) may be used for small applications.

605-3.3 Preparation of joints. Pavement joints for application of material in this specification must be dry, clean of all scale, dirt, dust, curing compound, and other foreign matter. The Contractor shall demonstrate, in the presence of the RPR, that the method cleans the joint and does not damage the joint.

a. Sawing. All joints shall be sawed in accordance with specifications and plan details. Immediately after sawing the joint, the resulting slurry shall be completely removed from joint and adjacent area by flushing with a jet of water, and by use of other tools as necessary.

b. Sealing. Immediately before sealing, the joints shall be thoroughly cleaned of all remaining laitance, curing compound, filler, protrusions of hardened concrete, old sealant and other foreign material from the sides and upper edges of the joint space to be sealed. Cleaning shall be accomplished by concrete saw or hand equipment as specified in paragraph 605-3.2. The newly exposed concrete joint faces and the pavement surface extending a minimum of 1/2 inch (12 mm) from the joint edge shall be sandblasted clean. Sandblasting shall be accomplished in a minimum of two passes. One pass per joint face with the nozzle held at an angle directly toward the joint face and not more than 3 inches (75 mm) from it. After final cleaning and immediately prior to sealing, blow out the joints with compressed air and leave them completely free of debris and water. The joint faces shall be surface dry when the seal is applied.

c. Backer Rod. When the joint opening is of a greater depth than indicated for the sealant depth, plug or seal off the lower portion of the joint opening using a backer rod in accordance with paragraph 605-2.2 to prevent the entrance of the sealant below the specified depth. Take care to ensure that the backer rod is placed at the specified depth and is not stretched or twisted during installation.

d. Bond-breaking tape. Where inserts or filler materials contain bitumen, or the depth of the joint opening does not allow for the use of a backup material, insert a bond-separating tape breaker in accordance with paragraph 605-2.3 to prevent incompatibility with the filler materials and three-sided adhesion of the sealant. Securely bond the tape to the bottom of the joint opening so it will not float up into the new sealant.

605-3.4 Installation of sealants. Joints shall be inspected for proper width, depth, alignment, and preparation, and shall be approved by the RPR before sealing is allowed. Sealants shall be installed in accordance with the following requirements:

Immediately preceding, but not more than 50 feet (15 m) ahead of the joint sealing operations, perform a final cleaning with compressed air. Fill the joints from the bottom up to ¼ (6 mm) ±1/16 inch (2 mm) below the top of pavement surface; or bottom of groove for grooved pavement. Remove and discard excess or spilled sealant from the pavement by approved methods. Install the sealant in such a manner as to prevent the formation of voids and entrapped air. In no case shall gravity methods or pouring pots be used to install the sealant material. Traffic shall not be permitted over newly sealed pavement until

authorized by the RPR. When a primer is recommended by the manufacturer, apply it evenly to the joint faces in accordance with the manufacturer's instructions. Check the joints frequently to ensure that the newly installed sealant is cured to a tack-free condition within the time specified.

605-3.5 Inspection. The Contractor shall inspect the joint sealant for proper rate of cure and set, bonding to the joint walls, cohesive separation within the sealant, reversion to liquid, entrapped air and voids. Sealants exhibiting any of these deficiencies at any time prior to the final acceptance of the project shall be removed from the joint, wasted, and replaced as specified at no additional cost to the airport.

605-3.6 Clean-up. Upon completion of the project, remove all unused materials from the site and leave the pavement in a clean condition.

METHOD OF MEASUREMENT

605-4.1 Joint Sealants for Pavements shall be measured based on the percentage of work completed as determined by the RPR.

BASIS OF PAYMENT

605-5.1 Joint Sealants for Pavements shall be paid for as a percentage of the contract lump sum based on the work completed as determined by the RPR.

Payment will be made under:

Item P-605	Joint Sealants for Pavements

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM D789	Standard Test Method for Determination of Relative Viscosity of Polyamide (PA)
ASTM D5249	Standard Specification for Backer Material for Use with Cold- and Hot-Applied Joint Sealants in Portland-Cement Concrete and Asphalt Joints

Advisory Circulars (AC)

AC 150/5340-30	Design and Installation Details for Airport Visual Aids

END ITEM P-605

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Item P-610 Concrete for Miscellaneous Structures

DESCRIPTION

610-1.1 This item shall consist of concrete and reinforcement, as shown on the plans, prepared and constructed in accordance with these specifications. This specification shall be used for all concrete other than airfield pavement which are cast-in-place.

MATERIALS

610-2.1 General. Only approved materials, conforming to the requirements of these specifications, shall be used in the work. Materials may be subject to inspection and tests at any time during their preparation or use. The source of all materials shall be approved by the Resident Project Representative (RPR) before delivery or use in the work. Representative preliminary samples of the materials shall be submitted by the Contractor, when required, for examination and test. Materials shall be stored and handled to ensure preservation of their quality and fitness for use and shall be located to facilitate prompt inspection. All equipment for handling and transporting materials and concrete must be clean before any material or concrete is placed in them.

The use of pit-run aggregates shall not be permitted unless the pit-run aggregate has been screened and washed, and all fine and coarse aggregates stored separately and kept clean. The mixing of different aggregates from different sources in one storage stockpile or alternating batches of different aggregates shall not be permitted.

a. Reactivity. Fine aggregate and coarse aggregates to be used in all concrete shall have been tested separately within six months of the project in accordance with ASTM C1260. Test results shall be submitted to the RPR. The aggregate shall be considered innocuous if the expansion of test specimens, tested in accordance with ASTM C1260, does not exceed 0.08% at 14 days (16 days from casting). If the expansion either or both test specimen is greater than 0.08% at 14 days, but less than 0.20%, a minimum of 25% of Type F fly ash, or between 40% and 55% of slag cement shall be used in the concrete mix.

If the expansion is greater than 0.20%, the aggregates shall not be used, and test results for other aggregates must be submitted for evaluation; or aggregates that meet P-501 reactivity test requirements may be utilized.

610-2.2 Coarse aggregate. The coarse aggregate for concrete shall meet the requirements of ASTM C33 and the requirements of Table 4, Class Designation 5S; and the grading requirements shown below, as required for the project.

Coarse Aggregate Grading Requirements

Maximum Aggregate Size	ASTM C33, Table 3 Grading Requirements (Size No.)
1 1/2 inch (37.5 mm)	467 or 4 and 67
1 inch (25 mm)	57
¾ inch (19 mm)	67
½ inch (12.5 mm)	7

610-2.2.1 Coarse Aggregate susceptibility to durability (D) cracking. Not used.

610-2.3 Fine aggregate. The fine aggregate for concrete shall meet all fine aggregate requirements of ASTM C33.

610-2.4 Cement. Cement shall conform to the requirements of ASTM C150 Type II.

610-2.5 Cementitious materials.

a. Fly ash. Fly ash shall meet the requirements of ASTM C618, with the exception of loss of ignition, where the maximum shall be less than 6%. Fly ash shall have a Calcium Oxide (CaO) content of less than 15% and a total available alkali content less than 3% per ASTM C311. Fly ash produced in furnace operations using liming materials or soda ash (sodium carbonate) as an additive shall not be acceptable. The Contractor shall furnish the previous three most recent, consecutive ASTM C618 reports for each source of fly ash proposed in the concrete mix, and shall furnish each additional report as they become available during the project. The reports can be used for acceptance or the material may be tested independently by the RPR.

b. Slag cement (ground granulated blast furnace (GGBF)). Slag cement shall conform to ASTM C989, Grade 100 or Grade 120. Slag cement shall be used only at a rate between 25% and 55% of the total cementitious material by mass.

610-2.6 Water. Water used in mixing or curing shall be from potable water sources. Other sources shall be tested in accordance with ASTM C1602 prior to use.

610-2.7 Admixtures. The Contractor shall submit certificates indicating that the material to be furnished meets all of the requirements indicated below. In addition, the RPR may require the Contractor to submit complete test data from an approved laboratory showing that the material to be furnished meets all of the requirements of the cited specifications. Subsequent tests may be made of samples taken by the RPR from the supply of the material being furnished or proposed for use on the work to determine whether the admixture is uniform in quality with that approved.

a. Air-entraining admixtures. Air-entraining admixtures shall meet the requirements of ASTM C260 and shall consistently entrain the air content in the specified ranges under field conditions. The air-entrainment agent and any water reducer admixture shall be compatible.

b. Water-reducing admixtures. Water-reducing admixture shall meet the requirements of ASTM C494, Type A, B, or D. ASTM C494, Type F and G high range water reducing admixtures and ASTM C1017 flowable admixtures shall not be used.

c. Other chemical admixtures. The use of set retarding, and set-accelerating admixtures shall be approved by the RPR. Retarding shall meet the requirements of ASTM C494, Type A, B, or D and set-

accelerating shall meet the requirements of ASTM C494, Type C. Calcium chloride and admixtures containing calcium chloride shall not be used.

610-2.8 Premolded joint material. Premolded joint material for expansion joints shall meet the requirements of ASTM D1751**.**

610-2.9 Joint filler. The filler for joints shall meet the requirements of Item P-605, unless otherwise specified.

610-2.10 Steel reinforcement.

a. Reinforcing shall consist of Plain-Steel Welded Wire Reinforcement:, fabricated from galvanized wire into flat sheets conforming to the requirements of ASTM A 185/A 185M**.**

b. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60, plain-steel bars.

c. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcement bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CSRI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified.

610-2.11 Materials for curing concrete. Curing materials shall conform to ASTM C171.

CONSTRUCTION METHODS

610-3.1 General. The Contractor shall furnish all labor, materials, and services necessary for, and incidental to, the completion of all work as shown on the drawings and specified here. All machinery and equipment used by the Contractor on the work, shall be of sufficient size to meet the requirements of the work. All work shall be subject to the inspection and approval of the RPR.

610-3.2 Concrete Mixture. The concrete shall develop a compressive strength of 4,500 psi in 28 days as determined by test cylinders made in accordance with ASTM C31 and tested in accordance with ASTM C39. The concrete shall contain not less than 615 pounds per cubic yard (365 kg per cubic meter). The water cementitious ratio shall not exceed 0.45 by weight. The air content of the concrete shall be 5% +/- 1.2% as determined by ASTM C231 and shall have a slump of not more than 4 inches (100 mm) as determined by ASTM C143.

610-3.3 Mixing. Concrete may be mixed at the construction site, at a central point, or wholly or in part in truck mixers. The concrete shall be mixed and delivered in accordance with the requirements of ASTM C94 or ASTM C685.

The concrete shall be mixed only in quantities required for immediate use. Concrete shall not be mixed while the air temperature is below 40°F (4°C) without the RPRs approval. If approval is granted for mixing under such conditions, aggregates or water, or both, shall be heated and the concrete shall be placed at a temperature not less than 50°F (10°C) nor more than 100°F (38°C). The Contractor shall be held responsible for any defective work, resulting from freezing or injury in any manner during placing and curing, and shall replace such work at his expense.

Retempering of concrete by adding water or any other material is not permitted.

The rate of delivery of concrete to the job shall be sufficient to allow uninterrupted placement of the concrete.

610-3.4 Forms. Concrete shall not be placed until all the forms and reinforcements have been inspected and approved by the RPR. Forms shall be of suitable material and shall be of the type, size, shape, quality, and strength to build the structure as shown on the plans. The forms shall be true to line and grade

and shall be mortar-tight and sufficiently rigid to prevent displacement and sagging between supports. The surfaces of forms shall be smooth and free from irregularities, dents, sags, and holes. The Contractor shall be responsible for their adequacy.

The internal form ties shall be arranged so no metal will show in the concrete surface or discolor the surface when exposed to weathering when the forms are removed. All forms shall be wetted with water or with a non-staining mineral oil, which shall be applied immediately before the concrete is placed. Forms shall be constructed so they can be removed without injuring the concrete or concrete surface.

610-3.5 Placing reinforcement. All reinforcement shall be accurately placed, as shown on the plans, and shall be firmly held in position during concrete placement. Bars shall be fastened together at intersections. The reinforcement shall be supported by approved metal chairs. Shop drawings, lists, and bending details shall be supplied by the Contractor when required.

610-3.6 Embedded items. Before placing concrete, all embedded items shall be firmly and securely fastened in place as indicated. All embedded items shall be clean and free from coating, rust, scale, oil, or any foreign matter. The concrete shall be spaded and consolidated around and against embedded items. The embedding of wood shall not be allowed.

610-3.7 Concrete Consistency. The Contractor shall monitor the consistency of the concrete delivered to the project site; collect each batch ticket; check temperature; and perform slump tests on each truck at the project site in accordance with ASTM C143.

610-3.8 Placing concrete. All concrete shall be placed during daylight hours, unless otherwise approved. The concrete shall not be placed until the depth and condition of foundations, the adequacy of forms and falsework, and the placing of the steel reinforcing have been approved by the RPR. Concrete shall be placed as soon as practical after mixing, but in no case later than one (1) hour after water has been added to the mix. The method and manner of placing shall avoid segregation and displacement of the reinforcement. Troughs, pipes, and chutes shall be used as an aid in placing concrete when necessary. The concrete shall not be dropped from a height of more than 5 feet (1.5 m). Concrete shall be deposited as nearly as practical in its final position to avoid segregation due to rehandling or flowing. Do not subject concrete to procedures which cause segregation. Concrete shall be placed on clean, damp surfaces, free from running water, or on a properly consolidated soil foundation.

610-3.9 Vibration. Vibration shall follow the guidelines in American Concrete Institute (ACI) Committee 309R, Guide for Consolidation of Concrete.

610-3.10 Joints. Joints shall be constructed as indicated on the plans.

610-3.11 Finishing. All exposed concrete surfaces shall be true, smooth, and free from open or rough areas, depressions, or projections. All concrete horizontal plane surfaces shall be brought flush to the proper elevation with the finished top surface struck-off with a straightedge and floated.

610-3.12 Curing and protection. All concrete shall be properly cured in accordance with the recommendations in American Concrete Institute (ACI) 308R, Guide to External Curing of Concrete. The concrete shall be protected from damage until project acceptance.

610-3.13 Cold weather placing. When concrete is placed at temperatures below 40°F (4°C), follow the cold weather concreting recommendations found in ACI 306R, Cold Weather Concreting.

610-3.14 Hot weather placing. When concrete is placed in hot weather greater than 85ºF (30 ºC), follow the hot weather concreting recommendations found in ACI 305R, Hot Weather Concreting.

QUALITY ASSURANCE (QA)

610-4.1 Quality Assurance sampling and testing. Concrete for each day's placement will be accepted on the basis of the compressive strength specified in paragraph 610-3.2. The RPR will sample the concrete in accordance with ASTM C172; test the slump in accordance with ASTM C143; test air content in accordance with ASTM C231, make and cure compressive strength specimens in accordance with ASTM C31; and test in accordance with ASTM C39. The QA testing agency will meet the requirements of ASTM C1077.

The Contractor shall provide adequate facilities for the initial curing of cylinders.

610-4.2 Defective work. Any defective work that cannot be satisfactorily repaired as determined by the RPR, shall be removed and replaced at the Contractor's expense. Defective work includes, but is not limited to, uneven dimensions, honeycombing and other voids on the surface or edges of the concrete.

METHOD OF MEASUREMENT

610-5.1 Concrete for Miscellaneous Structures shall be measured based on the percentage of work completed as determined by the RPR.

BASIS OF PAYMENT

610-6.1 Concrete for Miscellaneous Structures shall be paid for as a percentage of the contract lump sum based on the work completed as determined by the RPR.

Payment will be made under:

Item P-610	Concrete for Miscellaneous Structures

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM A184	Standard Specification for Welded Deformed Steel Bar Mats for Concrete Reinforcement
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A704	Standard Specification for Welded Steel Plain Bar or Rod Mats for Concrete Reinforcement
ASTM A706	Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement
ASTM A775	Standard Specification for Epoxy-Coated Steel Reinforcing Bars
ASTM A884	Standard Specification for Epoxy-Coated Steel Wire and Welded Wire Reinforcement
ASTM A934	Standard Specification for Epoxy-Coated Prefabricated Steel Reinforcing Bars

ASTM A1064	Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete
ASTM C31	Standard Practice for Making and Curing Concrete Test Specimens in the Field
ASTM C33	Standard Specification for Concrete Aggregates
ASTM C39	Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens
ASTM C94	Standard Specification for Ready-Mixed Concrete
ASTM C136	Standard Test Method for Sieve or Screen Analysis of Fine and Coarse Aggregates
ASTM C114	Standard Test Methods for Chemical Analysis of Hydraulic Cement
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates
ASTM C143	Standard Test Method for Slump of Hydraulic-Cement Concrete
ASTM C150	Standard Specification for Portland Cement
ASTM C171	Standard Specification for Sheet Materials for Curing Concrete
ASTM C172	Standard Practice for Sampling Freshly Mixed Concrete
ASTM C231	Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
ASTM C260	Standard Specification for Air-Entraining Admixtures for Concrete
ASTM C309	Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete
ASTM C311	Standard Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use in Portland-Cement Concrete
ASTM C494	Standard Specification for Chemical Admixtures for Concrete
ASTM C618	Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
ASTM C666	Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing
ASTM C685	Standard Specification for Concrete Made by Volumetric Batching and Continuous Mixing
ASTM C989	Standard Specification for Slag Cement for Use in Concrete and Mortars
ASTM C1017	Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete
ASTM C1077	Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation
ASTM C1157	Standard Performance Specification for Hydraulic Cement
ASTM C1260	Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method)

ASTM C1365	Standard Test Method for Determination of the Proportion of Phases in Portland Cement and Portland-Cement Clinker Using X-Ray Powder Diffraction Analysis
ASTM C1602	Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete
ASTM D1751	Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Asphalt Types)
ASTM D1752	Standard Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction

American Concrete Institute (ACI)

ACI 305R	Hot Weather Concreting
ACI 306R	Cold Weather Concreting
ACI 308R	Guide to External Curing of Concrete
ACI 309R	Guide for Consolidation of Concrete

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Item P-620 Runway and Taxiway Marking

DESCRIPTION

620-1.1 This item shall consist of the preparation and painting of numbers, markings, and stripes on the surface of runways, taxiways, and aprons, in accordance with these specifications and at the locations shown on the plans, or as directed by the Resident Project Representative (RPR). The terms "paint" and "marking material" as well as "painting" and "application of markings" are interchangeable throughout this specification.

MATERIALS

620-2.1 Materials acceptance. The Contractor shall furnish manufacturer's certified test reports, for materials shipped to the project. The certified test reports shall include a statement that the materials meet the specification requirements. This certification along with a copy of the paint manufacturer's surface preparation; marking materials, including adhesion, flow promoting and/or floatation additive; and application requirements must be submitted and approved by the Resident Project Representative (RPR) prior to the initial application of markings. The reports can be used for material acceptance or the RPR may perform verification testing. The reports shall not be interpreted as a basis for payment. The Contractor shall notify the RPR upon arrival of a shipment of materials to the site. All material shall arrive in sealed containers that are easily quantifiable for inspection by the RPR.

620-2.2 Marking materials.

Table 1. Marking Materials

Paint[1]				Glass Beads[2]	
Type	**Color**	**Fed Std. 595 Number**	**Application Rate Maximum**	**Type**	**Application Rate Minimum**
*Waterborne Type I	*White	37925*	115 ft^2/gal (2.8 m^2/l)	Type I Gradation A*	7 lb/gal (0.85 kg/l)*
*Waterborne Type I	*Yellow	33538*	115 ft^2/gal (2.8 m^2/l)	Type I Gradation A*	7 lb/gal (0.85 kg/l)*

[1] See paragraph 620-2.2a

[2] See paragraph 620-2.2b

a. Paint. Paint shall be waterborne in accordance with the requirements of this paragraph. Paint colors shall comply with Federal Standard No. 595.

Waterborne. Paint shall meet the requirements of Federal Specification TT-P-1952F, Type I. The non-volatile portion of the vehicle for all paint types shall be composed of a 100% acrylic polymer as determined by infrared spectral analysis. The acrylic resin used for Type III shall be 100% cross linking

acrylic as evidenced by infrared peaks at wavelengths 1568, 1624, and 1672 cm-l with intensities equal to those produced by an acrylic resin known to be 100% cross linking.

b. Reflective media. Glass beads for white and yellow paint shall meet the requirements for Federal Specification TT-B-1325D Type I, Gradation A.

Glass beads for red and pink paint shall meet the requirements for Type I, Gradation A.

Glass beads shall be treated with all compatible coupling agents recommended by the manufacturers of the paint and reflective media to ensure adhesion and embedment.

Glass beads shall not be used in black and green paint.

Type III glass beads shall not be used in red and pink paint.

CONSTRUCTION METHODS

620-3.1 Weather limitations. Painting shall only be performed when the surface is dry, and the ambient temperature and the pavement surface temperature meet the manufacturer's recommendations in accordance with paragraph 620-2.1. Painting operations shall be discontinued when the ambient or surface temperatures does not meet the manufacturer's recommendations. Markings shall not be applied when the wind speed exceeds 10 mph unless windscreens are used to shroud the material guns. Markings shall not be applied when weather conditions are forecasts to not be within the manufacturers' recommendations for application and dry time.

620-3.2 Equipment. Equipment shall include the apparatus necessary to properly clean the existing surface, a mechanical marking machine, a bead dispensing machine, and such auxiliary hand-painting equipment as may be necessary to satisfactorily complete the job.

The mechanical marker shall be an atomizing spray-type or airless type marking machine with automatic glass bead dispensers suitable for application of traffic paint. It shall produce an even and uniform film thickness and appearance of both paint and glass beads at the required coverage and shall apply markings of uniform cross-sections and clear-cut edges without running or spattering and without over spray. The marking equipment for both paint and beads shall be calibrated daily.

620-3.3 Preparation of surfaces. Immediately before application of the paint, the surface shall be dry and free from dirt, grease, oil, laitance, or other contaminates that would reduce the bond between the paint and the pavement. Use of any chemicals or impact abrasives during surface preparation shall be approved in advance by the RPR. After the cleaning operations, sweeping, blowing, or rinsing with pressurized water shall be performed to ensure the surface is clean and free of grit or other debris left from the cleaning process.

a. Preparation of new pavement surfaces. The area to be painted shall be cleaned by broom, blower, water blasting, or by other methods approved by the RPR to remove all contaminants, including PCC curing compounds, minimizing damage to the pavement surface.

b. Preparation of pavement to remove existing markings. Existing pavement markings shall be removed by rotary grinding, water blasting, or by other methods approved by the RPR minimizing damage to the pavement surface. The removal area may need to be larger than the area of the markings to eliminate ghost markings. After removal of markings on asphalt pavements, apply a fog seal or seal coat to 'block out' the removal area to eliminate 'ghost' markings.

c. Preparation of pavement markings prior to remarking. Prior to remarking existing markings, loose existing markings must be removed minimizing damage to the pavement surface, with a method approved by the RPR. After removal, the surface shall be cleaned of all residue or debris.

Prior to the application of markings, the Contractor shall certify in writing that the surface is dry and free from dirt, grease, oil, laitance, or other foreign material that would prevent the bond of the paint to the pavement or existing markings. This certification along with a copy of the paint manufactures application and surface preparation requirements must be submitted to the RPR prior to the initial application of markings.

620-3.4 Layout of markings. The proposed markings shall be laid out in advance of the paint application. The locations of markings to receive glass beads shall be shown on the plans.

620-3.5 Application. A period of **5** days shall elapse between placement of surface course or seal coat and application of the permanent paint markings. Paint shall be applied at the locations and to the dimensions and spacing shown on the plans. Paint shall not be applied until the layout and condition of the surface has been approved by the RPR.

The edges of the markings shall not vary from a straight line more than 1/2 inch (12 mm) in 50 feet (15 m), and marking dimensions and spacing shall be within the following tolerances:

Marking Dimensions and Spacing Tolerance

Dimension and Spacing	Tolerance
36 inch (910 mm) or less	±1/2 inch (12 mm)
greater than 36 inch to 6 feet (910 mm to 1.85 m)	±1 inch (25 mm)
greater than 6 feet to 60 feet (1.85 m to 18.3 m)	±2 inch (50 mm)
greater than 60 feet (18.3 m)	±3 inch (76 mm)

The paint shall be mixed in accordance with the manufacturer's instructions and applied to the pavement with a marking machine at the rate shown in Table 1. The addition of thinner will not be permitted.

Glass beads shall be distributed upon the marked areas at the locations shown on the plans to receive glass beads immediately after application of the paint. A dispenser shall be furnished that is properly designed for attachment to the marking machine and suitable for dispensing glass beads. Glass beads shall be applied at the rate shown in Table 1. Glass beads shall not be applied to black paint or green paint. Glass beads shall adhere to the cured paint or all marking operations shall cease until corrections are made. Different bead types shall not be mixed. Regular monitoring of glass bead embedment and distribution should be performed.

620-3.6 Application--preformed thermoplastic airport pavement markings. Not used.

620-3.7 Control strip. Prior to the full application of airfield markings, the Contractor shall prepare a control strip in the presence of the RPR. The Contractor shall demonstrate the surface preparation method and all striping equipment to be used on the project. The marking equipment must achieve the prescribed application rate of paint and population of glass beads (per Table 1) that are properly embedded and evenly distributed across the full width of the marking. Prior to acceptance of the control strip, markings must be evaluated during darkness to ensure a uniform appearance.

620-3.8 Retro-reflectance. Reflectance shall be measured with a portable retro-reflectometer meeting ASTM E1710 (or equivalent). A total of 6 readings shall be taken over a 6 square foot area with 3 readings taken from each direction. The average shall be equal to or above the minimum levels of all readings which are within 30% of each other.

Minimum Retro-Reflectance Values

Material	Retro-reflectance mcd/m^2/lux		
	White	**Yellow**	**Red**
Initial Type I	300	175	35
Initial Type III	600	300	35
Initial Thermoplastic	225	100	35
All materials, remark when less than[1]	100	75	10

620-3.9 Protection and cleanup. After application of the markings, all markings shall be protected from damage until dry. All surfaces shall be protected from excess moisture and/or rain and from disfiguration by spatter, splashes, spillage, or drippings. The Contractor shall remove from the work area all debris, waste, loose reflective media, and by-products generated by the surface preparation and application operations to the satisfaction of the RPR. The Contractor shall dispose of these wastes in strict compliance with all applicable state, local, and federal environmental statutes and regulations.

METHOD OF MEASUREMENT

620-4.1 Runway and Taxiway Marking shall be measured based on the percentage of work completed as determined by the RPR.

BASIS OF PAYMENT

620-5.1 Runway and Taxiway Marking shall be paid for as a percentage of the contract lump sum based on the work completed as determined by the RPR.

Payment will be made under:

Item P-620	Runway and Taxiway Marking

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM D476	Standard Classification for Dry Pigmentary Titanium Dioxide Products
ASTM D968	Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive
ASTM D1652	Standard Test Method for Epoxy Content of Epoxy Resins
ASTM D2074	Standard Test Method for Total, Primary, Secondary, and Tertiary Amine Values of Fatty Amines by Alternative Indicator Method

ASTM D2240	Standard Test Method for Rubber Property - Durometer Hardness
ASTM D7585	Standard Practice for Evaluating Retroreflective Pavement Markings Using Portable Hand-Operated Instruments
ASTM E303	Standard Test Method for Measuring Surface Frictional Properties Using the British Pendulum Tester
ASTM E1710	Standard Test Method for Measurement of Retroreflective Pavement Marking Materials with CEN-Prescribed Geometry Using a Portable Retroreflectometer
ASTM E2302	Standard Test Method for Measurement of the Luminance Coefficient Under Diffuse Illumination of Pavement Marking Materials Using a Portable Reflectometer
ASTM G154	Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials

Code of Federal Regulations (CFR)

40 CFR Part 60, Appendix A-7, Method 24
Determination of volatile matter content, water content, density, volume solids, and weight solids of surface coatings

29 CFR Part 1910.1200 Hazard Communication

Federal Specifications (FED SPEC)

FED SPEC TT-B-1325D	Beads (Glass Spheres) Retro-Reflective
FED SPEC TT-P-1952F	Paint, Traffic and Airfield Marking, Waterborne
FED STD 595	Colors used in Government Procurement

Commercial Item Description

A-A-2886B	Paint, Traffic, Solvent Based

Advisory Circulars (AC)

AC 150/5340-1	Standards for Airport Markings
AC 150/5320-12	Measurement, Construction, and Maintenance of Skid Resistant Airport Pavement Surfaces

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Part 10 – Fencing [NOT USED]

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Part 11 – Drainage

Item D-701 Pipe for Storm Drains and Culverts

DESCRIPTION

701-1.1 This item shall consist of the construction of pipe culverts and storm drains in accordance with these specifications and in reasonably close conformity with the lines and grades shown on the plans.

MATERIALS

701-2.1 Materials shall meet the requirements shown on the plans and specified below. Underground piping and components used in drainage systems for terminal and aircraft fueling ramp drainage shall be noncombustible and inert to fuel in accordance with National Fire Protection Association (NFPA) 415.

701-2.2 Pipe. The pipe shall be of the type called for on the plans or in the proposal and shall be in accordance with the following appropriate requirements:

American Association of State Highway and Transportation Officials (AASHTO) M167	Standard Specification for Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
AASHTO M190	Standard Specification for Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M196	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
AASHTO M219	Standard Specification for Corrugated Aluminum Alloy Structural Plate for Field-Bolted Pipe, Pipe-Arches, and Arches
AASHTO M243	Standard Specification for Field-Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches
AASHTO M252	Standard Specification for Corrugated Polyethylene Drainage Pipe
AASHTO M294	Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter
AASHTO M304	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
AASHTO MP20	Standard Specification for Steel Reinforced Polyethylene (PE) Ribbed Pipe, 300- to 900-mm (12- to 36-in.) Diameter
AASHTO R73	Standard Practice for Evaluation of Precast Concrete Drainage Productions
ASTM A760	Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains
ASTM A761	Standard Specification for Corrugated Structural Steel Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches

ASTM A762	Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM A849	Standard Specification for Post Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe
ASTM B745	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
ASTM C14	Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C506	Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
ASTM C507	Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain, and Sewer Pipe
ASTM C655	Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain, and Sewer Pipe
ASTM C1433	Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers
ASTM C1479	Standard Practice for Installation of Precast Concrete Sewer, Storm Drain, and Culvert Pipe Using Standard Installations
ASTM C1577	Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers Designed According to AASHTO LRFD
ASTM C1786	Standard Specification for Segmental Precast Reinforced Concrete Box Sections for Culverts, Storm Drains, and Sewers Designed According to AASHTO LRFD
ASTM C1840	Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain, and Storm Sewer Pipe
ASTM D3262	Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Sewer Pipe
ASTM D4161	Standard Specification for “Fiberglass” (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM F667	Standard Specification for 3 through 24 in Corrugated Polyethylene Pipe and Fittings
ASTM F714	Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter
ASTM F794	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe and Fittings Based on Controlled Inside Diameter
ASTM F894	Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F949	Standard Specification for Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings

ASTM F2435	Standard Specification for Steel Reinforced Polyethylene (PE) Corrugated Pipe
ASTM F2562	Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage
ASTM F2736	Standard Specification for 6 to 30 in. (152 to 762 mm) Polypropylene (PP) Corrugated Single Wall Pipe and Double Wall Pipe
ASTM F2764	Standard Specification for 30 to 60 in. (750 to 1500 mm) Polypropylene (PP) Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications
ASTM F2881	Standard Specification for 12 to 60 in. (300 to 1500 mm) Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications
ASTM D3034	Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings

701-2.3 Concrete. Concrete for pipe cradles shall have a minimum compressive strength of 2000 psi (13.8 MPa) at 28 days and conform to the requirements of ASTM C94.

701-2.4 Rubber gaskets. Rubber gaskets for rigid pipe shall conform to the requirements of ASTM C443. Rubber gaskets for PVC pipe, polyethylene, and polypropylene pipe shall conform to the requirements of ASTM F477. Rubber gaskets for zinc-coated steel pipe and precoated galvanized pipe shall conform to the requirements of ASTM D1056, for the "RE" closed cell grades. Rubber gaskets for steel reinforced thermoplastic ribbed pipe shall conform to the requirements of ASTM F477.

701-2.5 Joint mortar. Pipe joint mortar shall consist of one part Portland cement and two parts sand. The Portland cement shall conform to the requirements of ASTM C150, Type I. The sand shall conform to the requirements of ASTM C144.

701-2.6 Joint fillers. Not used.

701-2.7 Plastic gaskets. Plastic gaskets shall conform to the requirements of ASTM C990.

701-2.8. Controlled low-strength material (CLSM). Controlled low-strength material shall conform to the requirements of Item P-153. When CLSM is used, all joints shall have gaskets.

701-2.9 Precast box culverts. Manufactured in accordance with and conforming to ASTM C1433.

701-2.10 Precast concrete pipe. Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or American Concrete Pipe Association QCast Plant Certification program.

CONSTRUCTION METHODS

701-3.1 Excavation. The width of the pipe trench shall be sufficient to permit satisfactory jointing of the pipe and thorough tamping of the bedding material under and around the pipe, but it shall not be less than the external diameter of the pipe plus 12 inches (300 mm) on each side. The trench walls shall be approximately vertical.

The Contractor shall comply with all current federal, state and local rules and regulations governing the safety of men and materials during the excavation, installation and backfilling operations. Specifically, the Contractor shall observe that all requirements of the Occupational Safety and Health Administration (OSHA) relating to excavations, trenching and shoring are strictly adhered to. The width of the trench shall be sufficient to permit satisfactorily jointing of the pipe and thorough compaction of the bedding

material under the pipe and backfill material around the pipe, but it shall not be greater than the widths shown on the plans trench detail.

Where rock, hardpan, or other unyielding material is encountered, the Contractor shall remove it from below the foundation grade for a depth of at least 8 inch (200 mm) or 1/2 inch (12 mm) for each foot of fill over the top of the pipe (whichever is greater) but for no more than three-quarters of the nominal diameter of the pipe. The excavation below grade should be filled with granular material to form a uniform foundation.

Where a firm foundation is not encountered at the grade established, due to soft, spongy, or other unstable soil, the unstable soil shall be removed and replaced with approved granular material for the full trench width. The RPR shall determine the depth of removal necessary. The granular material shall be compacted to provide adequate support for the pipe.

The excavation for pipes placed in embankment fill shall not be made until the embankment has been completed to a height above the top of the pipe as shown on the plans.

701-3.2 Bedding. The bedding surface for the pipe shall provide a foundation of uniform density to support the pipe throughout its entire length.

a. Rigid pipe. The pipe bedding shall be constructed uniformly for the full length of the pipe barrel, as required on the plans. The maximum aggregate size shall be 1 in when the bedding thickness is less than 6 inches, and 1-1/2 in when the bedding thickness is greater than 6 inches. Bedding shall be loosely placed uncompacted material under the middle third of the pipe prior to placement of the pipe.

b. Flexible pipe. For flexible pipe, the bed shall be roughly shaped to fit the pipe, and a bedding blanket of sand or fine granular material shall be provided as follows:

Flexible Pipe Bedding

Pipe Corrugation Depth		Minimum Bedding Depth	
inch	**mm**	**inch**	**mm**
1/2	12	1	25
1	25	2	50
2	50	3	75
2-1/2	60	3-1/2	90

c. Other pipe materials. For PVC, polyethylene, polypropylene, or fiberglass pipe, the bedding material shall consist of coarse sands and gravels with a maximum particle size of 3/4 inches (19 mm). For pipes installed under paved areas, no more than 12% of the material shall pass the No. 200 (0.075 mm) sieve. For all other areas, no more than 50% of the material shall pass the No. 200 (0.075 mm) sieve. The bedding shall have a thickness of at least 6 inches (150 mm) below the bottom of the pipe and extend up around the pipe for a depth of not less than 50% of the pipe's vertical outside diameter.

701-3.3 Laying pipe. The pipe laying shall begin at the lowest point of the trench and proceed upgrade. The lower segment of the pipe shall be in contact with the bedding throughout its full length. Bell or groove ends of rigid pipes and outside circumferential laps of flexible pipes shall be placed facing upgrade.

Paved or partially lined pipe shall be placed so that the longitudinal center line of the paved segment coincides with the flow line.

Elliptical and elliptically reinforced concrete pipes shall be placed with the manufacturer's reference lines designating the top of the pipe within five degrees of a vertical plane through the longitudinal axis of the pipe.

701-3.4 Joining pipe. Joints shall be made with (1) cement mortar, (2) cement grout, (3) rubber gaskets, (4) plastic gaskets, (5) coupling bands.

Mortar joints shall be made with an excess of mortar to form a continuous bead around the outside of the pipe and shall be finished smooth on the inside. Molds or runners shall be used for grouted joints to retain the poured grout. Rubber ring gaskets shall be installed to form a flexible watertight seal.

a. Concrete pipe. Concrete pipe may be either bell and spigot or tongue and groove. Pipe sections at joints shall be fully seated and the inner surfaces flush and even. Concrete pipe joints shall be sealed with rubber gaskets meeting ASTM C443 when leak resistant joints are required. Concrete pipe joints shall be sealed with butyl mastic meeting ASTM C990 or mortar when soil tight joints are required. Joints shall be thoroughly wetted before applying mortar or grout.

b. Metal pipe. Metal pipe shall be firmly joined by form-fitting bands conforming to the requirements of ASTM A760 for steel pipe and AASHTO M196 for aluminum pipe.

c. PVC, Polyethylene, or Polypropylene pipe. Joints for PVC, Polyethylene, or Polypropylene pipe shall conform to the requirements of ASTM D3212 when leak resistant joints are required. Joints for PVC and Polyethylene pipe shall conform to the requirements of AASHTO M304 when soil tight joints are required. Fittings for polyethylene pipe shall conform to the requirements of AASHTO M252 or ASTM M294. Fittings for polypropylene pipe shall conform to ASTM F2881, ASTM F2736, or ASTM F2764.

d. Fiberglass pipe. Joints and fittings shall be as detailed on the plans and in accordance with the manufacturers recommendations. Joints shall meet the requirements of ASTM D4161 for flexible elastomeric seals.

701-3.5 Embedment and Overfill. Pipes shall be inspected before any fill material is placed; any pipes found to be out of alignment, unduly settled, or damaged shall be removed and re-laid or replaced at the Contractor's expense.

701-3.5-1 Embedment Material Requirements

a. Concrete Pipe. Embedment material and compaction requirements shall be in accordance with the applicable Type of Standard Installation (Types 1, 2, 3, or 4) per ASTM C1479. If a concrete cradle or CLSM embedment material is used, it shall conform to the plan details.

b. Plastic and fiberglass Pipe. Embedment material shall meet the requirements of ASTM D3282, A-1, A-2-4, A-2-5, or A-3. Embedment material shall be free of organic material, stones larger than 1.5 inches in the greatest dimension, or frozen lumps. Embedment material shall extend to 12 inches above the top of the pipe.

c. Metal Pipe. Embedment material shall be granular as specified in the contract document and specifications, and shall be free of organic material, rock fragments larger than 1.5 inches in the greatest dimension and frozen lumps. As a minimum, backfill materials shall meet the requirements of ASTM D3282, A-1, A-2, or A-3. Embedment material shall extend to 12 inches above the top of the pipe.

701-3.5-2 Placement of Embedment Material

The embedment material shall be compacted in layers not exceeding 6 inches (150 mm) on each side of the pipe and shall be brought up one foot (30 cm) above the top of the pipe or to natural ground level, whichever is greater. Thoroughly compact the embedment material under the haunches of the pipe without displacing the pipe. Material shall be brought up evenly on each side of the pipe for the full length of the pipe.

When the top of the pipe is above the top of the trench, the embedment material shall be compacted in layers not exceeding 6 inches (150 mm) and shall be brought up evenly on each side of the pipe to one foot (30 cm) above the top of the pipe. All embedment material shall be compacted to a density required under Item P-152.

Concrete cradles and flowable fills, such as controlled low strength material (CLSM) or controlled density fill (CDF), may be used for embedment provided adequate flotation resistance can be achieved by restraints, weighing, or placement technique.

It shall be the Contractor's responsibility to protect installed pipes and culverts from damage due to construction equipment operations. The Contractor shall be responsible for installation of any extra strutting or backfill required to protect pipes from the construction equipment.

701-3.6 Overfill

Pipes shall be inspected before any overfill is in place. Any pipes found to be out of alignment, unduly settled, or damaged shall be removed and relaid or replaced at the Contractor's expense. Evaluation of any damage to RCP shall be evaluated based on AASHTO R73.

Overfill material shall be place and compacted in layers as required to achieve compaction to at least 95 percent standard proctor per **[** ASTM D698 **] [** ASTM D1557 **]**. The soil shall contain no debris, organic matter, frozen material, or stones with a diameter greater than one half the thickness of the compacted layers being placed.

701-3.7 Inspection Requirements

An initial post installation inspection shall be performed by the RPR no sooner than 30 days after completion of installation and final backfill. Clean or flush all lines prior to inspection.

Reinforced concrete pipe shall be inspected, evaluated, and reported on in accordance with ASTM C1840, "Standard Practice for Inspection and Acceptance of Installed Reinforced Concrete Culvert, Storm Drain, and Storm Sewer Pipe." Any issues reported shall include still photo and video documentation. **]**

METHOD OF MEASUREMENT

701-4.1 Pipe for Storm Drains and Culverts shall be measured based on the percentage of work completed of the contract lump sum as determined by the RPR.

BASIS OF PAYMENT

701-5.1 Pipe for Storm Drains and Culverts will be paid for as a percentage of the contract lump sum based on the work completed as determined by the RPR.

Payment will be made under:

Item 701	Pipe for Storm Drains and Culverts

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO M167	Standard Specification for Corrugated Steel Structural Plate, Zinc-Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches

AASHTO M190	Standard Specification for Bituminous-Coated Corrugated Metal Culvert Pipe and Pipe Arches
AASHTO M196	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
AASHTO M219	Standard Specification for Corrugated Aluminum Alloy Structural Plate for Field-Bolted Pipe, Pipe-Arches, and Arches
AASHTO M243	Standard Specification for Field Applied Coating of Corrugated Metal Structural Plate for Pipe, Pipe-Arches, and Arches
AASHTO M252	Standard Specification for Corrugated Polyethylene Drainage Pipe
AASHTO M294	Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter
AASHTO M304	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Wall Drain Pipe and Fittings Based on Controlled Inside Diameter
AASHTO MP20	Standard Specification for Steel Reinforced Polyethylene (PE) Ribbed Pipe, 300- to 900-mm (12- to 36-in.) Diameter

ASTM International (ASTM)

ASTM A760	Standard Specification for Corrugated Steel Pipe, Metallic Coated for Sewers and Drains
ASTM A761	Standard Specification for Corrugated Steel Structural Plate, Zinc Coated, for Field-Bolted Pipe, Pipe-Arches, and Arches
ASTM A762	Standard Specification for Corrugated Steel Pipe, Polymer Precoated for Sewers and Drains
ASTM A849	Standard Specification for Post-Applied Coatings, Pavings, and Linings for Corrugated Steel Sewer and Drainage Pipe
ASTM B745	Standard Specification for Corrugated Aluminum Pipe for Sewers and Drains
ASTM C14	Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe
ASTM C76	Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe
ASTM C94	Standard Specification for Ready Mixed Concrete
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets
ASTM C506	Standard Specification for Reinforced Concrete Arch Culvert, Storm Drain, and Sewer Pipe
ASTM C507	Standard Specification for Reinforced Concrete Elliptical Culvert, Storm Drain and Sewer Pipe

ASTM C655	Standard Specification for Reinforced Concrete D-Load Culvert, Storm Drain and Sewer Pipe
ASTM C990	Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants
ASTM C1433	Standard Specification for Precast Reinforced Concrete Monolithic Box Sections for Culverts, Storm Drains, and Sewers
ASTM D1056	Standard Specification for Flexible Cellular Materials Sponge or Expanded Rubber
ASTM D3034	Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings
ASTM D3212	Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals
ASTM D3262	Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Sewer Pipe
ASTM D3282	Standard Practice for Classification of Soils and Soil-Aggregate Mixtures for Highway Construction Purposes
ASTM D4161	Standard Specification for "Fiberglass" (Glass-Fiber Reinforced Thermosetting Resin) Pipe Joints Using Flexible Elastomeric Seals
ASTM D6690	Standard Specification for Joint and Crack Sealants, Hot Applied, for Concrete and Asphalt Pavements
ASTM F477	Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe
ASTM F667	Standard Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings
ASTM F714	Standard Specification for Polyethylene (PE) Plastic Pipe (DR PR) Based on Outside Diameter
ASTM F794	Standard Specification for Poly (Vinyl Chloride) (PVC) Profile Gravity Sewer Pipe & Fittings Based on Controlled Inside Diameter
ASTM F894	Standard Specification for Polyethylene (PE) Large Diameter Profile Wall Sewer and Drain Pipe
ASTM F949	Standard Specification for Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings
ASTM F2435	Standard Specification for Steel Reinforced Polyethylene (PE) Corrugated Pipe
ASTM F2562	Specification for Steel Reinforced Thermoplastic Ribbed Pipe and Fittings for Non-Pressure Drainage and Sewerage
ASTM F2736	Standard Specification for 6 to 30 in. (152 to 762 mm) Polypropylene (PP) Corrugated Single Wall Pipe and Double Wall Pipe
ASTM F2764	Standard Specification for 30 to 60 in. (750 to 1500 mm) Polypropylene (PP) Triple Wall Pipe and Fittings for Non-Pressure Sanitary Sewer Applications

ASTM F2881	Standard Specification for 12 to 60 in. (300 to 1500 mm) Polypropylene (PP) Dual Wall Pipe and Fittings for Non-Pressure Storm Sewer Applications

National Fire Protection Association (NFPA)

NFPA 415	Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways

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Item D-751 Manholes, Catch Basins, Inlets and Inspection Holes

DESCRIPTION

751-1.1 This item shall consist of construction of manholes, catch basins, inlets, and inspection holes, in accordance with these specifications, at the specified locations and conforming to the lines, grades, and dimensions shown on the plans or required by the RPR.

MATERIALS

751-2.1 Brick. The brick shall conform to the requirements of ASTM C32, Grade MS.

751-2.2 Mortar. Mortar shall consist of one part Portland cement and two parts sand. The cement shall conform to the requirements of ASTM C150, Type I. The sand shall conform to the requirements of ASTM C144.

751-2.3 Concrete. Plain and reinforced concrete used in structures, connections of pipes with structures, and the support of structures or frames shall conform to the requirements of Item P-610.

751-2.4 Precast concrete pipe manhole rings. Precast concrete pipe manhole rings shall conform to the requirements of ASTM C478. Unless otherwise specified, the risers and offset cone sections shall have an inside diameter of not less than 36 inches (90 cm) nor more than 48 inches (120 cm). There shall be a gasket between individual sections and sections cemented together with mortar on the inside of the manhole. Gaskets shall conform to the requirements of ASTM C443.

751-2.5 Corrugated metal. Corrugated metal shall conform to the requirements of American Association of State Highway and Transportation Officials (AASHTO) M36.

751-2.6 Frames, covers, and grates. The castings shall conform to one of the following requirements:

a. ASTM A48, Class 35B: Gray iron castings

b. ASTM A47: Malleable iron castings

c. ASTM A27: Steel castings

d. ASTM A283, Grade D: Structural steel for grates and frames

e. ASTM A536, Grade 65-45-12: Ductile iron castings

f. ASTM A897: Austempered ductile iron castings

All castings or structural steel units shall conform to the dimensions shown on the plans and shall be designed to support the loadings, aircraft gear configuration and/or direct loading, specified.

Each frame and cover or grate unit shall be provided with fastening members to prevent it from being dislodged by traffic but which will allow easy removal for access to the structure.

All castings shall be thoroughly cleaned. After fabrication, structural steel units shall be galvanized to meet the requirements of ASTM A123.

751-2.7 Steps. The steps or ladder bars shall be gray or malleable cast iron or galvanized steel. The steps shall be the size, length, and shape shown on the plans and those steps that are not galvanized shall be given a coat of asphalt paint, when directed.

751-2.8 Precast inlet structures. Manufactured in accordance with and conforming to ASTM C913.

CONSTRUCTION METHODS

751-3.1 Unclassified excavation.

a. The Contractor shall excavate for structures and footings to the lines and grades or elevations, shown on the plans, or as staked by the RPR. The excavation shall be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown. The elevations of the bottoms of footings, as shown on the plans, shall be considered as approximately only; and the RPR may direct, in writing, changes in dimensions or elevations of footings necessary for a satisfactory foundation.

b. Boulders, logs, or any other objectionable material encountered in excavation shall be removed. All rock or other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped, or serrated, as directed by the RPR. All seams or crevices shall be cleaned out and grouted. All loose and disintegrated rock and thin strata shall be removed. Where concrete will rest on a surface other than rock, the bottom of the excavation shall not be disturbed and excavation to final grade shall not be made until immediately before the concrete or reinforcing is placed.

c. The Contractor shall do all bracing, sheathing, or shoring necessary to implement and protect the excavation and the structure as required for safety or conformance to governing laws. The cost of bracing, sheathing, or shoring shall be included in the unit price bid for the structure.

d. All bracing, sheathing, or shoring involved in the construction of this item shall be removed by the Contractor after the completion of the structure. Removal shall not disturb or damage finished masonry. The cost of removal shall be included in the unit price bid for the structure.

e. After excavation is completed for each structure, the Contractor shall notify the RPR. No concrete or reinforcing steel shall be placed until the RPR has approved the depth of the excavation and the character of the foundation material.

751-3.2 Brick structures.

a. Foundations. A prepared foundation shall be placed for all brick structures after the foundation excavation is completed and accepted. Unless otherwise specified, the base shall consist of reinforced concrete mixed, prepared, and placed in accordance with the requirements of Item P-610.

b. Laying brick. All brick shall be clean and thoroughly wet before laying so that they will not absorb any appreciable amount of additional water at the time they are laid. All brick shall be laid in freshly made mortar. Mortar not used within 45 minutes after water has been added shall be discarded. Retempering of mortar shall not be permitted. An ample layer of mortar shall be spread on the beds and a shallow furrow shall be made in it that can be readily closed by the laying of the brick. All bed and head joints shall be filled solid with mortar. End joints of stretchers and side or cross joints of headers shall be fully buttered with mortar and a shoved joint made to squeeze out mortar at the top of the joint. Any bricks that may be loosened after the mortar has taken its set, shall be removed, cleaned, and re-laid with fresh mortar. No broken or chipped brick shall be used in the face, and no spalls or bats shall be used except where necessary to shape around irregular openings or edges; in which case, full bricks shall be placed at ends or corners where possible, and the bats shall be used in the interior of the course. In making closures, no piece of brick shorter than the width of a whole brick shall be used; and wherever practicable, whole brick shall be used and laid as headers.

c. Joints. All joints shall be filled with mortar at every course Exterior faces shall be laid up in advance of backing. Exterior faces shall be plastered or parged with a coat of mortar not less than 3/8 inch (9 mm) thick before the backing is laid up. Prior to parging, all joints on the back of face courses shall be

cut flush. Unless otherwise noted, joints shall be not less than 1/4 inch (6 mm) nor more than 1/2 inch (12 mm) wide and the selected joint width shall be maintained uniform throughout the work.

d. Pointing. Face joints shall be neatly struck, using the weather-struck joint. All joints shall be finished properly as the laying of the brick progresses. When nails or line pins are used, the holes shall be immediately plugged with mortar and pointed when the nail or pin is removed.

e. Cleaning. Upon completion of the work all exterior surfaces shall be thoroughly cleaned by scrubbing and washing with water. If necessary to produce satisfactory results, cleaning shall be done with a 5% solution of muriatic acid which shall then be rinsed off with liberal quantities of water.

f. Curing and cold weather protection. The brick masonry shall be protected and kept moist for at least 48 hours after laying the brick. Brick masonry work or pointing shall not be done when there is frost on the brick or when the air temperature is below 50°F (10°C) unless the Contractor has, on the project ready to use, suitable covering and artificial heating devices necessary to keep the atmosphere surrounding the masonry at a temperature of not less than 60°F (16°C) for the duration of the curing period.

751-3.3 Concrete structures. Concrete structures which are to be cast-in-place within the project boundaries shall be built on prepared foundations, conforming to the dimensions and shape indicated on the plans. The construction shall conform to the requirements specified in Item P-610. Any reinforcement required shall be placed as indicated on the plans and shall be approved by the RPR before the concrete is placed.

All invert channels shall be constructed and shaped accurately to be smooth, uniform, and cause minimum resistance to flowing water. The interior bottom shall be sloped to the outlet.

751-3.4 Precast concrete structures. Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or another RPR approved third party certification program.

Precast concrete structures shall conform to ASTM C478. Precast concrete structures shall be constructed on prepared or previously placed slab foundations conforming to the dimensions and locations shown on the plans. All precast concrete sections necessary to build a completed structure shall be furnished. The different sections shall fit together readily. Joints between precast concrete risers and tops shall be full-bedded in cement mortar and shall: (1) be smoothed to a uniform surface on both interior and exterior of the structure or (2) utilize a rubber gasket per ASTM C443. The top of the upper precast concrete section shall be suitably formed and dimensioned to receive the metal frame and cover or grate, or other cap, as required. Provision shall be made for any connections for lateral pipe, including drops and leads that may be installed in the structure. The flow lines shall be smooth, uniform, and cause minimum resistance to flow. The metal or metal encapsulated steps that are embedded or built into the side walls shall be aligned and placed in accordance to ASTM C478. When a metal ladder replaces the steps, it shall be securely fastened into position.

751-3.5 Corrugated metal structures. Corrugated metal structures shall be prefabricated. All standard or special fittings shall be furnished to provide pipe connections or branches with the correct dimensions and of sufficient length to accommodate connecting bands. The fittings shall be welded in place to the metal structures. The top of the metal structure shall be designed so that either a concrete slab or metal collar may be attached to allow the fastening of a standard metal frame and grate or cover. Steps or ladders shall be furnished as shown on the plans. Corrugated metal structures shall be constructed on prepared foundations, conforming to the dimensions and locations as shown on the plans. When indicated, the structures shall be placed on a reinforced concrete base.

751-3.6 Inlet and outlet pipes. Inlet and outlet pipes shall extend through the walls of the structures a sufficient distance beyond the outside surface to allow for connections. They shall be cut off flush with

the wall on the inside surface of the structure, unless otherwise directed. For concrete or brick structures, mortar shall be placed around these pipes to form a tight, neat connection.

751-3.7 Placement and treatment of castings, frames, and fittings. All castings, frames, and fittings shall be placed in the positions indicated on the plans or as directed by the RPR, and shall be set true to line and elevation. If frames or fittings are to be set in concrete or cement mortar, all anchors or bolts shall be in place before the concrete or mortar is placed. The unit shall not be disturbed until the mortar or concrete has set.

When frames or fittings are placed on previously constructed masonry, the bearing surface of the masonry shall be brought true to line and grade and shall present an even bearing surface so the entire face or back of the unit will come in contact with the masonry. The unit shall be set in mortar beds and anchored to the masonry as indicated on the plans or as directed by the RPR. All units shall set firm and secure.

After the frames or fittings have been set in final position, the concrete or mortar shall be allowed to harden for seven (7) days before the grates or covers are placed and fastened down.

751-3.8 Installation of steps. The steps shall be installed as indicated on the plans or as directed by the RPR. When the steps are to be set in concrete, they shall be placed and secured in position before the concrete is placed. When the steps are installed in brick masonry, they shall be placed as the masonry is being built. The steps shall not be disturbed or used until the concrete or mortar has hardened for at least seven (7) days. After seven (7) days, the steps shall be cleaned and painted, unless they have been galvanized.

When steps are required with precast concrete structures they shall meet the requirements of ASTM C478. The steps shall be cast into the side of the sections at the time the sections are manufactured or set in place after the structure is erected by drilling holes in the concrete and cementing the steps in place.

When steps are required with corrugated metal structures, they shall be welded into aligned position at a vertical spacing of 12 inches (300 mm).

Instead of steps, prefabricated ladders may be installed. For brick or concrete structures, the ladder shall be held in place by grouting the supports in drilled holes. For metal structures, the ladder shall be secured by welding the top support to the structure and grouting the bottom support into drilled holes in the foundation or as directed by the RPR.

751-3.9 Backfilling.

a. After a structure has been completed, the area around it shall be backfilled with approved material, in horizontal layers not to exceed 8 inches (200 mm) in loose depth, and compacted to the density required in Item P-152. Each layer shall be deposited evenly around the structure to approximately the same elevation. The top of the fill shall meet the elevation shown on the plans or as directed by the RPR.

b. Backfill shall not be placed against any structure until approved by the RPR. For concrete structures, approval shall not be given until the concrete has been in place seven (7) days, or until tests establish that the concrete has attained sufficient strength to withstand any pressure created by the backfill and placing methods.

c. Backfill shall not be measured for direct payment. Performance of this work shall be considered an obligation of the Contractor covered under the contract unit price for the structure involved.

751-3.10 Cleaning and restoration of site. After the backfill is completed, the Contractor shall dispose of all surplus material, dirt, and rubbish from the site. Surplus dirt may be deposited in embankments, shoulders, or as approved by the RPR. The Contractor shall restore all disturbed areas to their original condition. The Contractor shall remove all tools and equipment, leaving the entire site free, clear, and in good condition.

METHOD OF MEASUREMENT

751-4.1 Manholes, Catch Basins, Inlets and Inspection Holes shall be measured based on the percentage of work completed of the contract lump sum as determined by the RPR.

BASIS OF PAYMENT

751-5.1 Manholes, Catch Basins, Inlets and Inspection Holes will be paid for as a percentage of the contract lump sum based on the work completed as determined by the RPR.

Payment will be made under:

Item D-751	Manholes, Catch Basins, Inlets and Inspection Holes Manholes

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM A27	Standard Specification for Steel Castings, Carbon, for General App.
ASTM A47	Standard Specification for Ferritic Malleable Iron Castings
ASTM A48	Standard Specification for Gray Iron Castings
ASTM A123	Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A283	Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A897	Standard Specification for Austempered Ductile Iron Castings
ASTM C32	Standard Specification for Sewer and Manhole Brick (Made from Clay or Shale)
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C443	Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
ASTM C478	Standard Specification for Precast Reinforced Concrete Manhole Sections
ASTM C913	Standard Specification for Precast Concrete Water and Wastewater Structures.

American Association of State Highway and Transportation Officials (AASHTO)

AASHTO M36	Standard Specification for Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains

END OF ITEM D-751

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Item D-752 Concrete Culverts, Headwalls, and Miscellaneous Drainage Structures

DESCRIPTION

752-1.1 This item shall consist of reinforced concrete culverts, headwalls, and miscellaneous drainage structures constructed in accordance with these specifications, at the specified locations and conforming to the lines, grades, and dimensions shown on the plans or required by the RPR.

MATERIALS

752-2.1 Concrete. Reinforced concrete shall meet the requirements of Item P-610.

CONSTRUCTION METHODS

752-3.1 Unclassified excavation.

a. Trenches and foundation pits for structures or structure footings shall be excavated to the lines and grades and elevations shown on the plans. The excavation shall be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown. The elevations of the bottoms of footings, as shown on the plans, shall be considered as approximate only; and the RPR may approve, in writing, changes in dimensions or elevations of footings necessary to secure a satisfactory foundation.

b. Boulders, logs, or any other objectionable material encountered in excavation shall be removed. All rock or other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped, or serrated, as directed by the RPR. All seams or crevices shall be cleaned out and grouted. All loose and disintegrated rock and thin strata shall be removed. When concrete will rest on a surface other than rock, the bottom of the excavation shall not be disturbed and excavation to final grade shall not be made until immediately before the concrete or reinforcing steel is placed.

c. The Contractor shall do all bracing, sheathing, or shoring necessary to perform and protect the excavation and the structure as required for safety or conformance to governing laws. The cost of bracing, sheathing, or shoring shall be included in the unit price bid for excavation.

d. All bracing, sheathing, or shoring shall be removed by the Contractor after the completion of the structure. Removal shall not disturb or damage the finished concrete. The cost of removal shall be included in the unit price bid for excavation.

e. After each excavation is completed, the Contractor shall notify the RPR. No concrete or reinforcing steel shall be placed until the RPR has approved the depth of the excavation and the character of the foundation material.

752-3.2 Backfilling.

a. After a structure has been completed, backfilling with approved material shall be accomplished by applying the fill in horizontal layers not to exceed 8 inches (200 mm) in loose depth, and compacted. The field density of the compacted material shall be at least 90% of the maximum density for cohesive soils and 95% of the maximum density for noncohesive soils. The maximum density shall be determined in accordance with ASTM D698. The field density shall be determined in accordance with ASTM D1556.

b. No backfilling shall be placed against any structure until approved by the RPR. For concrete, approval shall not be given until the concrete has been in place seven (7) days, or until tests establish that the concrete has attained sufficient strength to withstand any pressure created by the backfill or the placement methods.

c. Fill placed around concrete culverts shall be deposited on each side at the same time and to approximately the same elevation. All slopes bounding or within the areas to be backfilled shall be stepped or serrated to prevent wedge action against the structure.

d. Backfill will not be measured for direct payment. Performance of this work shall be considered as a subsidiary obligation of the Contractor, covered under the contract unit price for "unclassified excavation for structures."

752-3.3 Weep holes. Weep holes shall be constructed as shown on the plans.

752-3.4 Cleaning and restoration of site. After the backfill is completed, the Contractor shall dispose of all surplus material, dirt, and rubbish from the site. Surplus dirt may be deposited in embankment, shoulders, or as approved by the RPR. The Contractor shall restore all disturbed areas to their original condition. The Contractor shall remove all tools and equipment, leaving the entire site free, clear, and in good condition.

METHOD OF MEASUREMENT

752-4.1 Concrete Culverts, Headwalls, and Miscellaneous Drainage Structures shall be measured based on the percentage of work completed of the contract lump sum as determined by the RPR.

BASIS OF PAYMENT

752-5.1 Concrete Culverts, Headwalls, and Miscellaneous Drainage Structures will be paid for as a percentage of the contract lump sum based on the work completed as determined by the RPR.

Payment will be made under:

Item D-752	Concrete Culverts, Headwalls, and Miscellaneous Drainage Structures

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM D698	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft^3 (600 kN-m/m^3))
ASTM D1556	Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method

END OF ITEM D-752

Part 12 – Turfing

Item T-901 Seeding

DESCRIPTION

901-1.1 This item shall consist of soil preparation, seeding, and fertilizing the areas shown on the plans or as directed by the RPR in accordance with these specifications.

MATERIALS

901-2.1 Seed. The species and application rates of grass, legume, and cover-crop seed furnished shall be those stipulated herein. Seed shall conform to the requirements of Federal Specification JJJ-S-181, Federal Specification, Seeds, Agricultural.

Seed shall be furnished separately or in mixtures in standard containers labeled in conformance with the Agricultural Marketing Service (AMS) Seed Act and applicable state seed laws with the seed name, lot number, net weight, percentages of purity and of germination and hard seed, and percentage of maximum weed seed content clearly marked for each kind of seed. The Contractor shall furnish the RPR duplicate signed copies of a statement by the vendor certifying that each lot of seed has been tested by a recognized laboratory for seed testing within six (6) months of date of delivery. This statement shall include: name and address of laboratory, date of test, lot number for each kind of seed, and the results of tests as to name, percentages of purity and of germination, and percentage of weed content for each kind of seed furnished, and, in case of a mixture, the proportions of each kind of seed. Wet, moldy, or otherwise damaged seed will be rejected.

Seeds shall be applied as follows:

Seed Properties and Rate of Application

Seed	Minimum Seed Purity (Percent)	Minimum Germination (Percent)	Rate of Application lb/acre (or lb/1,000 S.F.)
*	*	*	*
*	*	*	*

Seeding shall be performed during the period between March 15th and October 31st inclusive, unless otherwise approved by the RPR.

901-2.2 Lime. Not required.

901-2.3 Fertilizer. Fertilizer shall be standard commercial fertilizers supplied separately or in mixtures containing the percentages of total nitrogen, available phosphoric acid, and water-soluble potash. They shall be applied at the rate and to the depth specified, and shall meet the requirements of applicable state laws. They shall be furnished in standard containers with name, weight, and guaranteed analysis of contents clearly marked thereon. No cyanamide compounds or hydrated lime shall be permitted in mixed fertilizers.

The fertilizers may be supplied in one of the following forms:

a. A dry, free-flowing fertilizer suitable for application by a common fertilizer spreader;

b. A finely-ground fertilizer soluble in water, suitable for application by power sprayers; or

c. A granular or pellet form suitable for application by blower equipment.

901-2.4 Soil for repairs. The soil for fill and topsoiling of areas to be repaired shall be at least of equal quality to that which exists in areas adjacent to the area to be repaired. The soil shall be relatively free from large stones, roots, stumps, or other materials that will interfere with subsequent sowing of seed, compacting, and establishing turf, and shall be approved by the RPR before being placed.

CONSTRUCTION METHODS

901-3.1 Advance preparation and cleanup. After grading of areas has been completed and before applying fertilizer and ground limestone, areas to be seeded shall be raked or otherwise cleared of stones larger than 2 inches (50 mm) in any diameter, sticks, stumps, and other debris that might interfere with sowing of seed, growth of grasses, or subsequent maintenance of grass-covered areas. If any damage by erosion or other causes has occurred after the completion of grading and before beginning the application of fertilizer and ground limestone, the Contractor shall repair such damage include filling gullies, smoothing irregularities, and repairing other incidental damage.

An area to be seeded shall be considered a satisfactory seedbed without additional treatment if it has recently been thoroughly loosened and worked to a depth of not less than 5 inches (125 mm) as a result of grading operations and, if immediately prior to seeding, the top 3 inches (75 mm) of soil is loose, friable, reasonably free from large clods, rocks, large roots, or other undesirable matter, and if shaped to the required grade.

When the area to be seeded is sparsely sodded, weedy, barren and unworked, or packed and hard, any grass and weeds shall first be cut or otherwise satisfactorily disposed of, and the soil then scarified or otherwise loosened to a depth not less than 5 inches (125 mm). Clods shall be broken and the top 3 inches (75 mm) of soil shall be worked into a satisfactory seedbed by discing, or by use of cultipackers, rollers, drags, harrows, or other appropriate means.

901-3.2 Dry application method.

a. Liming. Not required.

b. Fertilizing. Following advance preparations and cleanup fertilizer shall be uniformly spread at the rate that will provide not less than the minimum quantity stated in paragraph 901-2.3.

c. Seeding. Grass seed shall be sown at the rate specified in paragraph 901-2.1 immediately after fertilizing. The fertilizer and seed shall be raked within the depth range stated in the special provisions. Seeds of legumes, either alone or in mixtures, shall be inoculated before mixing or sowing, in accordance with the instructions of the manufacturer of the inoculant. When seeding is required at other than the seasons shown on the plans or in the special provisions, a cover crop shall be sown by the same methods required for grass and legume seeding.

d. Rolling. After the seed has been properly covered, the seedbed shall be immediately compacted by means of an approved lawn roller, weighing 40 to 65 pounds per foot (60 to 97 kg per meter) of width for clay soil (or any soil having a tendency to pack), and weighing 150 to 200 pounds per foot (223 to 298 kg per meter) of width for sandy or light soils.

901-3.3 Wet application method.

a. General. The Contractor may elect to apply seed and fertilizer (and lime, if required) by spraying them on the previously prepared seedbed in the form of an aqueous mixture and by using the methods and equipment described herein. The rates of application shall be as specified in the special provisions.

b. Spraying equipment. The spraying equipment shall have a container or water tank equipped with a liquid level gauge calibrated to read in increments not larger than 50 gallons (190 liters) over the entire range of the tank capacity, mounted so as to be visible to the nozzle operator. The container or tank shall also be equipped with a mechanical power-driven agitator capable of keeping all the solids in the mixture in complete suspension at all times until used.

The unit shall also be equipped with a pressure pump capable of delivering 100 gallons (380 liters) per minute at a pressure of 100 lb / sq inches (690 kPa). The pump shall be mounted in a line that will recirculate the mixture through the tank whenever it is not being sprayed from the nozzle. All pump passages and pipe lines shall be capable of providing clearance for 5/8 inch (16 mm) solids. The power unit for the pump and agitator shall have controls mounted so as to be accessible to the nozzle operator. There shall be an indicating pressure gauge connected and mounted immediately at the back of the nozzle.

The nozzle pipe shall be mounted on an elevated supporting stand in such a manner that it can be rotated through 360 degrees horizontally and inclined vertically from at least 20 degrees below to at least 60 degrees above the horizontal. There shall be a quick-acting, three-way control valve connecting the recirculating line to the nozzle pipe and mounted so that the nozzle operator can control and regulate the amount of flow of mixture delivered to the nozzle. At least three different types of nozzles shall be supplied so that mixtures may be properly sprayed over distance varying from 20 to 100 feet (6 to 30 m). One shall be a close-range ribbon nozzle, one a medium-range ribbon nozzle, and one a long-range jet nozzle. For case of removal and cleaning, all nozzles shall be connected to the nozzle pipe by means of quick-release couplings.

In order to reach areas inaccessible to the regular equipment, an extension hose at least 50 feet (15 m) in length shall be provided to which the nozzles may be connected.

c. Mixtures. Lime, if required, shall be applied separately, in the quantity specified, prior to the fertilizing and seeding operations. Not more than 220 pounds (100 kg) of lime shall be added to and mixed with each 100 gallons (380 liters) of water. Seed and fertilizer shall be mixed together in the relative proportions specified, but not more than a total of 220 pounds (100 kg) of these combined solids shall be added to and mixed with each 100 gallons (380 liters) of water.

All water used shall be obtained from fresh water sources and shall be free from injurious chemicals and other toxic substances harmful to plant life. The Contractor shall identify to the RPR all sources of water at least two (2) weeks prior to use. The RPR may take samples of the water at the source or from the tank at any time and have a laboratory test the samples for chemical and saline content. The Contractor shall not use any water from any source that is disapproved by the RPR following such tests.

All mixtures shall be constantly agitated from the time they are mixed until they are finally applied to the seedbed. All such mixtures shall be used within two (2) hours from the time they were mixed or they shall be wasted and disposed of at approved locations.

d. Spraying. Lime, if required, shall be sprayed only upon previously prepared seedbeds. After the applied lime mixture has dried, the lime shall be worked into the top 3 inches (75 mm), after which the seedbed shall again be properly graded and dressed to a smooth finish.

Mixtures of seed and fertilizer shall only be sprayed upon previously prepared seedbeds on which the lime, if required, shall already have been worked in. The mixtures shall be applied by means of a high-pressure spray that shall always be directed upward into the air so that the mixtures will fall to the ground like rain in a uniform spray. Nozzles or sprays shall never be directed toward the ground in such a manner as might produce erosion or runoff.

Particular care shall be exercised to ensure that the application is made uniformly and at the prescribed rate and to guard against misses and overlapped areas. Proper predetermined quantities of the mixture in accordance with specifications shall be used to cover specified sections of known area.

Checks on the rate and uniformity of application may be made by observing the degree of wetting of the ground or by distributing test sheets of paper or pans over the area at intervals and observing the quantity of material deposited thereon.

On surfaces that are to be mulched as indicated by the plans or designated by the RPR, seed and fertilizer applied by the spray method need not be raked into the soil or rolled. However, on surfaces on which mulch is not to be used, the raking and rolling operations will be required after the soil has dried.

901-3.4 Maintenance of seeded areas. The Contractor shall protect seeded areas against traffic or other use by warning signs or barricades, as approved by the RPR. Surfaces gullied or otherwise damaged following seeding shall be repaired by regrading and reseeding as directed. The Contractor shall mow, water as directed, and otherwise maintain seeded areas in a satisfactory condition until final inspection and acceptance of the work.

When either the dry or wet application method outlined above is used for work done out of season, it will be required that the Contractor establish a good stand of grass of uniform color and density to the satisfaction of the RPR. A grass stand shall be considered adequate when bare spots are one square foot (0.01 sq m) or less, randomly dispersed, and do not exceed 3% of the area seeded.

METHOD OF MEASUREMENT

901-4.1 Seeding shall be measured based on the percentage of work completed of the contract lump sum as determined by the RPR.

BASIS OF PAYMENT

901-5.1 Seeding will be paid for as a percentage of the contract lump sum based on the work completed as determined by the RPR.

Payment will be made under:

Item 901	Seeding

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C602	Standard Specification for Agricultural Liming Materials

Federal Specifications (FED SPEC)

FED SPEC	JJJ-S-181, Federal Specification, Seeds, Agricultural

Advisory Circulars (AC)

AC 150/5200-33	Hazardous Wildlife Attractants on or Near Airports

FAA/United States Department of Agriculture

Wildlife Hazard Management at Airports, A Manual for Airport Personnel

END OF ITEM T-901

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Item T-905 Topsoil

DESCRIPTION

905-1.1 This item shall consist of preparing the ground surface for topsoil application, removing topsoil from designated stockpiles or areas to be stripped on the site or from approved sources off the site, and placing and spreading the topsoil on prepared areas in accordance with this specification at the locations shown on the plans or as directed by the RPR.

MATERIALS

905-2.1 Topsoil. Topsoil shall be the surface layer of soil with no admixture of refuse or any material toxic to plant growth, and it shall be reasonably free from subsoil and stumps, roots, brush, stones (2 inches (50 mm) or more in diameter), and clay lumps or similar objects. Brush and other vegetation that will not be incorporated with the soil during handling operations shall be cut and removed. Ordinary sod and herbaceous growth such as grass and weeds are not to be removed, but shall be thoroughly broken up and intermixed with the soil during handling operations. Heavy sod or other cover, which cannot be incorporated into the topsoil by discing or other means, shall be removed. The topsoil or soil mixture, unless otherwise specified or approved, shall have a pH range of approximately 5.5 pH to 7.6 pH, when tested in accordance with the methods of testing of the Association of Official Agricultural Chemists in effect on the date of invitation of bids. The organic content shall be not less than 3% nor more than 20% as determined by the wet-combustion method (chromic acid reduction). There shall be not less than 20% nor more than 80% of the material passing the 200 mesh (75 μm) sieve as determined by the wash test in accordance with ASTM C117.

Natural topsoil may be amended by the Contractor with approved materials and methods to meet the above specifications.

905-2.2 Inspection and tests. Within 10 days following acceptance of the bid, the RPR shall be notified of the source of topsoil to be furnished by the Contractor. The topsoil shall be inspected to determine if the selected soil meets the requirements specified and to determine the depth to which stripping will be permitted. At this time, the Contractor may be required to take representative soil samples from several locations within the area under consideration and to the proposed stripping depths, for testing purposes as specified in paragraph 905-2.1.

CONSTRUCTION METHODS

905-3.1 General. Areas to be topsoiled shall be shown on the plans. If topsoil is available on the site, the location of the stockpiles or areas to be stripped of topsoil and the stripping depths shall be shown on the plans.

Suitable equipment necessary for proper preparation and treatment of the ground surface, stripping of topsoil, and for the handling and placing of all required materials shall be on hand, in good condition, and approved by the RPR before the various operations are started.

905-3.2 Preparing the ground surface. Immediately prior to dumping and spreading the topsoil on any area, the surface shall be loosened by discs or spike-tooth harrows, or by other means approved by the RPR, to a minimum depth of 2 inches (50 mm) to facilitate bonding of the topsoil to the covered subgrade

soil. The surface of the area to be topsoiled shall be cleared of all stones larger than 2 inches (50 mm) in any diameter and all litter or other material which may be detrimental to proper bonding, the rise of capillary moisture, or the proper growth of the desired planting. Limited areas, as shown on the plans, which are too compact to respond to these operations shall receive special scarification.

Grades on the area to be topsoiled, which have been established by others as shown on the plans, shall be maintained in a true and even condition. Where grades have not been established, the areas shall be smooth-graded and the surface left at the prescribed grades in an even and compacted condition to prevent the formation of low places or pockets where water will stand.

905-3.3 Obtaining topsoil. Prior to the stripping of topsoil from designated areas, any vegetation, briars, stumps and large roots, rubbish or stones found on such areas, which may interfere with subsequent operations, shall be removed using methods approved by the RPR. Heavy sod or other cover, which cannot be incorporated into the topsoil by discing or other means shall be removed.

When suitable topsoil is available on the site, the Contractor shall remove this material from the designated areas and to the depth as directed by the RPR. The topsoil shall be spread on areas already tilled and smooth-graded, or stockpiled in areas approved by the RPR. Any topsoil stockpiled by the Contractor shall be rehandled and placed without additional compensation. Any topsoil that has been stockpiled on the site by others, and is required for topsoil purposes, shall be removed and placed by the Contractor. The sites of all stockpiles and areas adjacent thereto which have been disturbed by the Contractor shall be graded if required and put into a condition acceptable for seeding.

When suitable topsoil is secured off the airport site, the Contractor shall locate and obtain the supply, subject to the approval of the RPR. The Contractor shall notify the RPR sufficiently in advance of operations in order that necessary measurements and tests can be made. The Contractor shall remove the topsoil from approved areas and to the depth as directed. The topsoil shall be hauled to the site of the work and placed for spreading, or spread as required. Any topsoil hauled to the site of the work and stockpiled shall be rehandled and placed without additional compensation.

905-3.4 Placing topsoil. The topsoil shall be evenly spread on the prepared areas to a uniform depth of 2 inches (50 mm) after compaction, unless otherwise shown on the plans or stated in the special provisions. Spreading shall not be done when the ground or topsoil is frozen, excessively wet, or otherwise in a condition detrimental to the work. Spreading shall be carried on so that turfing operations can proceed with a minimum of soil preparation or tilling.

After spreading, any large, stiff clods and hard lumps shall be broken with a pulverizer or by other effective means, and all stones or rocks (2 inches (50 mm) or more in diameter), roots, litter, or any foreign matter shall be raked up and disposed of by the Contractor. after spreading is completed, the topsoil shall be satisfactorily compacted by rolling with a cultipacker or by other means approved by the RPR. The compacted topsoil surface shall conform to the required lines, grades, and cross-sections. Any topsoil or other dirt falling upon pavements as a result of hauling or handling of topsoil shall be promptly removed.

METHOD OF MEASUREMENT

905-4.1 Topsoil shall be measured based on the percentage of work completed of the contract lump sum as determined by the RPR.

BASIS OF PAYMENT

905-5.1 Topsoil will be paid for as a percentage of the contract lump sum based on the work completed as determined by the RPR.

Payment will be made under:

Item T-905	Topsoil

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ASTM International (ASTM)

ASTM C117	Materials Finer than 75 μm (No. 200) Sieve in Mineral Aggregates by Washing

Advisory Circulars (AC)

AC 150/5200-33	Hazardous Wildlife Attractants on or Near Airports

FAA/United States Department of Agriculture

Wildlife Hazard Management at Airports, A Manual for Airport Personnel

END OF ITEM T-905

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Part 13 – Lighting Installation

Item L-108 Underground Power Cable for Airports

DESCRIPTION

108-1.1 This item shall consist of furnishing and installing power cables that are direct buried and furnishing and/or installing power cables within conduit or duct banks per these specifications at the locations shown on the plans. It includes excavation and backfill of trench for direct-buried cables only. Also included are the installation of counterpoise wires, ground wires, ground rods and connections, cable splicing, cable marking, cable testing, and all incidentals necessary to place the cable in operating condition as a completed unit to the satisfaction of the RPR. This item shall not include the installation of duct banks or conduit, trenching and backfilling for duct banks or conduit, or furnishing or installation of cable for FAA owned/operated facilities.

EQUIPMENT AND MATERIALS

108-2.1 General.

a. Airport lighting equipment and materials covered by advisory circulars (AC) shall be approved under the Airport Lighting Equipment Certification Program per AC 150/5345-53, current version.

b. All other equipment and materials covered by other referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification, when requested by the RPR.

c. Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications. Materials supplied and/or installed that do not comply with these specifications shall be removed (when directed by the RPR) and replaced with materials that comply with these specifications at the Contractor's cost.

d. All materials and equipment used to construct this item shall be submitted to the RPR for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete any non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment to which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in the project that may accrue directly or indirectly from late submissions or resubmissions of submittals.

e. The data submitted shall be sufficient, in the opinion of the RPR, to determine compliance with the plans and specifications. The Contractor's submittals shall be electronically submitted in pdf format. The RPR reserves the right to reject any and all equipment, materials, or procedures that do not meet the system design and the standards and codes, specified in this document.

f. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for at least twelve (12) months from the date of final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's

discretion, with no additional cost to the Owner. The Contractor shall maintain a minimum insulation resistance in accordance with paragraph 108-3.10e with isolation transformers connected in new circuits and new segments of existing circuits through the end of the contract warranty period when tested in accordance with AC 150/5340-26, *Maintenance Airport Visual Aid Facilities*, paragraph 5.1.3.1, Insulation Resistance Test.

108-2.2 Cable. Underground cable for airfield lighting facilities (runway and taxiway lights and signs) shall conform to the requirements of AC 150/5345-7, Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits latest edition. Conductors for use on 6.6 ampere primary airfield lighting series circuits shall be single conductor, seven strand, #8 American wire gauge (AWG), L-824 Type B 5,000 volts, non-shielded, with ethylene propylene insulation. Conductors for use on 20 ampere primary airfield lighting series circuits shall be single conductor, seven strand, #6 AWG, L-824 Type B, 5,000 volts, non-shielded, with ethylene propylene insulation. L-824 conductors for use on the L-830 secondary of airfield lighting series circuits shall be sized in accordance with the manufacturer's recommendations. All other conductors shall comply with FAA and National Electric Code (NEC) requirements. Conductor sizes noted above shall not apply to leads furnished by manufacturers on airfield lighting transformers and fixtures.

Wire for electrical circuits up to 600 volts shall comply with Specification L-824 and/or Commercial Item Description A-A-59544A and shall be type THWN-2, 75°C for installation in conduit and RHW-2, 75°C for direct burial installations. Conductors for parallel (voltage) circuits shall be type and size and installed in accordance with NFPA-70, National Electrical Code.

Unless noted otherwise, all 600-volt and less non-airfield lighting conductor sizes are based on a 75°C, THWN-2, 600-volt insulation, copper conductors, not more than three single insulated conductors, in raceway, in free air. The conduit/duct sizes are based on the use of THWN-2, 600-volt insulated conductors. The Contractor shall make the necessary increase in conduit/duct sizes for other types of wire insulation. In no case shall the conduit/duct size be reduced. The minimum power circuit wire size shall be #12 AWG.

Conductor sizes may have been adjusted due to voltage drop or other engineering considerations. Equipment provided by the Contractor shall be capable of accepting the quantity and sizes of conductors shown in the Contract Documents. All conductors, pigtails, cable step-down adapters, cable step-up adapters, terminal blocks and splicing materials necessary to complete the cable termination/splice shall be considered incidental to the respective pay items provided.

Cable type, size, number of conductors, strand and service voltage shall be as specified in the Contract Document.

108-2.3 Bare copper wire (counterpoise, bare copper wire ground and ground rods). Wire for counterpoise or ground installations for airfield lighting systems shall be No. 6 AWG bare solid copper wire for counterpoise and/or No. 6 AWG insulated stranded for grounding bond wire per ASTM B3 and ASTM B8, and shall be bare copper wire. For voltage powered circuits, the equipment grounding conductor shall comply with NEC Article 250.

Ground rods shall be copper. The ground rods shall be of the length and diameter specified on the plans, but in no case be less than 8 feet (2.4 m) long and 5/8 inch (16 mm) in diameter.

108-2.4 Cable connections. In-line connections or splices of underground primary cables shall be of the type called for on the plans, and shall be one of the types listed below. No separate payment will be made for cable connections.

a. The cast splice. A cast splice, employing a plastic mold and using epoxy resin equivalent to that manufactured by 3M™ Company, "Scotchcast" Kit No. 82-B, or an approved equivalent, used for potting the splice is acceptable.

b. The field-attached plug-in splice. Field attached plug-in splices shall be installed as shown on the plans. The Contractor shall determine the outside diameter of the cable to be spliced and furnish appropriately sized connector kits and/or adapters. Tape or heat shrink tubing with integral sealant shall be in accordance with the manufacturer's requirements. Primary Connector Kits manufactured by Amerace, "Super Kit", Integro "Complete Kit", or approved equal is acceptable.

c. The factory-molded plug-in splice. Specification for L-823 Connectors, Factory-Molded to Individual Conductors, is acceptable.

d. The taped or heat-shrink splice. Taped splices employing field-applied rubber, or synthetic rubber tape covered with plastic tape is acceptable. The rubber tape should meet the requirements of ASTM D4388 and the plastic tape should comply with Military Specification MIL-I-24391 or Commercial Item Description A-A-55809. Heat shrinkable tubing shall be heavy-wall, self-sealing tubing rated for the voltage of the wire being spliced and suitable for direct-buried installations. The tubing shall be factory coated with a thermoplastic adhesive-sealant that will adhere to the insulation of the wire being spliced forming a moisture- and dirt-proof seal. Additionally, heat shrinkable tubing for multi-conductor cables, shielded cables, and armored cables shall be factory kits that are designed for the application. Heat shrinkable tubing and tubing kits shall be manufactured by Tyco Electronics/ Raychem Corporation, Energy Division, or approved equivalent.

In all the above cases, connections of cable conductors shall be made using crimp connectors using a crimping tool designed to make a complete crimp before the tool can be removed. All L-823/L-824 splices and terminations shall be made per the manufacturer's recommendations and listings.

All connections of counterpoise, grounding conductors and ground rods shall be made by the exothermic process or approved equivalent, except that a light base ground clamp connector shall be used for attachment to the light base. All exothermic connections shall be made per the manufacturer's recommendations and listings.

108-2.5 Splicer qualifications. Every airfield lighting cable splicer shall be qualified in making airport cable splices and terminations on cables rated at or above 5,000 volts AC. The Contractor shall submit to the RPR proof of the qualifications of each proposed cable splicer for the airport cable type and voltage level to be worked on. Cable splicing/terminating personnel shall have a minimum of three (3) years continuous experience in terminating/splicing medium voltage cable.

108-2.6 Concrete. Concrete shall be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures.

108-2.7 Flowable backfill. Flowable material used to backfill trenches for power cable trenches shall conform to the requirements of Item P-153, Controlled Low Strength Material.

108-2.8 Cable identification tags. Cable identification tags shall be made from a non-corrosive material with the circuit identification stamped or etched onto the tag. The tags shall be of the type as detailed on the plans.

108-2.9 Tape. Electrical tapes shall be Scotch™ Electrical Tapes –Scotch™ 88 (1-1/2 inch (38 mm) wide) and Scotch™ 130C® linerless rubber splicing tape (2-inch (50 mm) wide), as manufactured by the Minnesota Mining and Manufacturing Company (3M™), or an approved equivalent.

108-2.10 Electrical coating. Electrical coating shall be Scotchkote™ as manufactured by 3M™, or an approved equivalent.

108-2.11 Existing circuits. Whenever the scope of work requires connection to an existing circuit, the existing circuit's insulation resistance shall be tested, in the presence of the RPR. The test shall be performed per this item and prior to any activity that will affect the respective circuit. The Contractor shall record the results on forms acceptable to the RPR. When the work affecting the circuit is complete, the circuit's insulation resistance shall be checked again, in the presence of the RPR. The Contractor shall

record the results on forms acceptable to the RPR. The second reading shall be equal to or greater than the first reading or the Contractor shall make the necessary repairs to the existing circuit to bring the second reading above the first reading. All repair costs including a complete replacement of the L-823 connectors, L-830 transformers and L-824 cable, if necessary, shall be borne by the Contractor. All test results shall be submitted in the Operation and Maintenance (O&M) Manual.

108-2.12 Detectable warning tape. Plastic, detectable, American Public Works Association (APWA) Red (electrical power lines, cables, conduit and lighting cable) with continuous legend tape shall be polyethylene film with a metalized foil core and shall be 3-6 inches (75-150 mm) wide. Detectable tape is incidental to the respective bid item. Detectable warning tape for communication cables shall be orange. Detectable warning tape color code shall comply with the APWA Uniform Color Code.

CONSTRUCTION METHODS

108-3.1 General. The Contractor shall install the specified cable at the approximate locations indicated on the plans. Unless otherwise shown on the plans, all cable required to cross under pavements expected to carry aircraft loads shall be installed in concrete encased duct banks. Cable shall be run without splices, from fixture to fixture.

Cable connections between lights will be permitted only at the light locations for connecting the underground cable to the primary leads of the individual isolation transformers. The Contractor shall be responsible for providing cable in continuous lengths for home runs or other long cable runs without connections unless otherwise authorized in writing by the RPR or shown on the plans.

In addition to connectors being installed at individual isolation transformers, L-823 cable connectors for maintenance and test points shall be installed at locations shown on the plans. Cable circuit identification markers shall be installed on both sides of the L-823 connectors installed and on both sides of slack loops where a future connector would be installed.

Provide not less than 3 feet (1 m) of cable slack on each side of all connections, isolation transformers, light units, and at points where cable is connected to field equipment. Where provisions must be made for testing or for future above grade connections, provide enough slack to allow the cable to be extended at least one foot (30 cm) vertically above the top of the access structure. This requirement also applies where primary cable passes through empty light bases, junction boxes, and access structures to allow for future connections, or as designated by the RPR.

Primary airfield lighting cables installed shall have cable circuit identification markers attached on both sides of each L-823 connector and on each airport lighting cable entering or leaving cable access points, such as manholes, hand holes, pull boxes, junction boxes, etc. Markers shall be of sufficient length for imprinting the cable circuit identification legend on one line, using letters not less than 1/4 inch (6 mm) in size. The cable circuit identification shall match the circuits noted on the construction plans.

108-3.2 Installation in duct banks or conduits. This item includes the installation of the cable in duct banks or conduit per the following paragraphs. The maximum number and voltage ratings of cables installed in each single duct or conduit, and the current-carrying capacity of each cable shall be per the latest version of the National Electric Code, or the code of the local agency or authority having jurisdiction.

The Contractor shall make no connections or splices of any kind in cables installed in conduits or duct banks.

Unless otherwise designated in the plans, where ducts are in tiers, use the lowest ducts to receive the cable first, with spare ducts left in the upper levels. Check duct routes prior to construction to obtain assurance that the shortest routes are selected and that any potential interference is avoided.

Duct banks or conduits shall be installed as a separate item per Item L-110, Airport Underground Electrical Duct Banks and Conduit. The Contractor shall run a mandrel through duct banks or conduit prior to installation of cable to ensure that the duct bank or conduit is open, continuous and clear of debris. The mandrel size shall be compatible with the conduit size. The Contractor shall swab out all conduits/ducts and clean light bases, manholes, etc., interiors immediately prior to pulling cable. Once cleaned and swabbed, the light bases and all accessible points of entry to the duct/conduit system shall be kept closed except when installing cables. Cleaning of ducts, light bases, manholes, etc., is incidental to the pay item of the item being cleaned. All raceway systems left open, after initial cleaning, for any reason shall be re-cleaned at the Contractor's expense. The Contractor shall verify existing ducts proposed for use in this project as clear and open. The Contractor shall notify the RPR of any blockage in the existing ducts.

The cable shall be installed in a manner that prevents harmful stretching of the conductor, damage to the insulation, or damage to the outer protective covering. The ends of all cables shall be sealed with moisture-seal tape providing moisture-tight mechanical protection with minimum bulk, or alternately, heat shrinkable tubing before pulling into the conduit and it shall be left sealed until connections are made. Where more than one cable is to be installed in a conduit, all cable shall be pulled in the conduit at the same time. The pulling of a cable through duct banks or conduits may be accomplished by hand winch or power winch with the use of cable grips or pulling eyes. Maximum pulling tensions shall not exceed the cable manufacturer's recommendations. A non-hardening cable-pulling lubricant recommended for the type of cable being installed shall be used where required.

The Contractor shall submit the recommended pulling tension values to the RPR prior to any cable installation. If required by the RPR, pulling tension values for cable pulls shall be monitored by a dynamometer in the presence of the RPR. Cable pull tensions shall be recorded by the Contractor and reviewed by the RPR. Cables exceeding the maximum allowable pulling tension values shall be removed and replaced by the Contractor at the Contractor's expense.

The manufacturer's minimum bend radius or NEC requirements (whichever is more restrictive) shall apply. Cable installation, handling and storage shall be per manufacturer's recommendations. During cold weather, particular attention shall be paid to the manufacturer's minimum installation temperature. Cable shall not be installed when the temperature is at or below the manufacturer's minimum installation temperature. At the Contractor's option, the Contractor may submit a plan, for review by the RPR, for heated storage of the cable and maintenance of an acceptable cable temperature during installation when temperatures are below the manufacturer's minimum cable installation temperature.

Cable shall not be dragged across base can or manhole edges, pavement or earth. When cable must be coiled, lay cable out on a canvas tarp or use other appropriate means to prevent abrasion to the cable jacket.

108-3.3 Installation of direct-buried cable in trenches. Unless otherwise specified, the Contractor shall not use a cable plow for installing the cable. Cable shall be unreeled uniformly in place alongside or in the trench and shall be carefully placed along the bottom of the trench. The cable shall not be unreeled and pulled into the trench from one end. Slack cable sufficient to provide strain relief shall be placed in the trench in a series of S curves. Sharp bends or kinks in the cable shall not be permitted.

Where cables must cross over each other, a minimum of 3 inches (75 mm) vertical displacement shall be provided with the topmost cable depth at or below the minimum required depth below finished grade.

a. Trenching. Where turf is well established and the sod can be removed, it shall be carefully stripped and properly stored. Trenches for cables may be excavated manually or with mechanical trenching equipment. Walls of trenches shall be essentially vertical so that a minimum of surface is disturbed. Graders shall not be used to excavate the trench with their blades. The bottom surface of trenches shall be essentially smooth and free from coarse aggregate. Unless otherwise specified, cable

trenches shall be excavated to a minimum depth of 18 inches (0.5 m) below finished grade per NEC Table 300.5, except as follows:

- When off the airport or crossing under a roadway or driveway, the minimum depth shall be 36 inches (91 cm) unless otherwise specified.
- Minimum cable depth when crossing under a railroad track, shall be 42 inches (1 m) unless otherwise specified.

The Contractor shall excavate all cable trenches to a width not less than 6 inches (150 mm). Unless otherwise specified on the plans, all cables in the same location and running in the same general direction shall be installed in the same trench.

When rock is encountered, the rock shall be removed to a depth of at least 3 inches (75 mm) below the required cable depth and it shall be replaced with bedding material of earth or sand containing no mineral aggregate particles that would be retained on a 1/4-inch (6.3 mm) sieve. Flowable backfill material may alternatively be used.

Duct bank or conduit markers temporarily removed for trench excavations shall be replaced as required.

It is the Contractor's responsibility to locate existing utilities within the work area prior to excavation. Where existing active cables cross proposed installations, the Contractor shall ensure that these cables are adequately protected. Where crossings are unavoidable, no splices will be allowed in the existing cables, except as specified on the plans. Installation of new cable where such crossings must occur shall proceed as follows:

(1) Existing cables shall be located manually. Unearthed cables shall be inspected to assure absolutely no damage has occurred.

(2) Trenching, etc., in cable areas shall then proceed, with approval of the RPR, with care taken to minimize possible damage or disruption of existing cable, including careful backfilling in area of cable.

In the event that any previously identified cable is damaged during the course of construction, the Contractor shall be responsible for the complete repair or replacement.

b. Backfilling. After the cable has been installed, the trench shall be backfilled. The first layer of backfill in the trench shall encompass all cables ; be 3 inches (75 mm) deep, loose measurement; and shall be either earth or sand containing no mineral aggregate particles that would be retained on a 1/4-inch (6.3 mm) sieve. This layer shall not be compacted. The second layer shall be 5 inches (125 mm) deep, loose measurement, and shall contain no particles that would be retained on a one inch (25.0 mm) sieve. The remaining third and subsequent layers of backfill shall not exceed 8 inches (20 cm) of loose measurement and be excavated or imported material and shall not contain stone or aggregate larger than 4 inches (100 mm) maximum diameter.

The second and subsequent layers shall be thoroughly tamped and compacted to at least the density of the adjacent material. If the cable is to be installed in locations or areas where other compaction requirements are specified (under pavements, embankments, etc.) the backfill compaction shall be to a minimum of 95 percent of ASTM D1557**.**

Trenches shall not contain pools of water during backfilling operations. The trench shall be completely backfilled and tamped level with the adjacent surface, except that when turf is to be established over the trench, the backfilling shall be stopped at an appropriate depth consistent with the type of turfing operation to be accommodated. A proper allowance for settlement shall also be provided. Any excess excavated material shall be removed and disposed of per the plans and specifications.

Underground electrical warning (caution) tape shall be installed in the trench above all direct-buried cable. Contractor shall submit a sample of the proposed warning tape for acceptance by the RPR. If not

shown on the plans, the warning tape shall be located 6 inches (150 mm) above the direct-buried cable or the counterpoise wire if present. A 3-6 inch (75 - 150 mm) wide polyethylene film detectable tape, with a metalized foil core, shall be installed above all direct buried cable or counterpoise. The tape shall be of the color and have a continuous legend as indicated on the plans. The tape shall be installed 8 inches (200 mm) minimum below finished grade.

c. Restoration. Following restoration of all trenching near airport movement surfaces, the Contractor shall visually inspect the area for foreign object debris (FOD) and remove any that is found. Where soil and sod has been removed, it shall be replaced as soon as possible after the backfilling is completed. All areas disturbed by work shall be restored to its original condition. The restoration shall include the topsoiling and seeding as shown on the plans. The Contractor shall be held responsible for maintaining all disturbed surfaces and replacements until final acceptance. When trenching is through paved areas, restoration shall be equal to existing conditions. If the cable is to be installed in locations or areas where other compaction requirements are specified (under pavements, embankments, etc.) the backfill compaction shall be to a minimum of 100 percent of ASTM D1557. Restoration shall be considered incidental to the pay item of which it is a component part.

108-3.4 Cable markers for direct-buried cable. The location of direct buried circuits shall be marked by a concrete slab marker, 2 feet (60 cm) square and 4-6 inch (10 - 15 cm) thick, extending approximately one inch (25 mm) above the surface. Each cable run from a line of lights and signs to the equipment vault shall be marked at approximately every 200 feet (61 m) along the cable run, with an additional marker at each change of direction of cable run. All other direct-buried cable shall be marked in the same manner. Cable markers shall be installed directly above the cable. The Contractor shall impress the word "CABLE" and directional arrows on each cable marking slab. The letters shall be approximately 4 inches (100 mm) high and 3 inches (75 mm) wide, with width of stroke 1/2 inch (12 mm) and 1/4 inch (6 mm) deep. Stencils shall be used for cable marker lettering; no hand lettering shall be permitted.

At the location of each underground cable connection/splice, except at lighting units, or isolation transformers, a concrete marker slab shall be installed to mark the location of the connection/splice. The Contractor shall impress the word "SPLICE" on each slab. The Contractor also shall impress additional circuit identification symbols on each slab as directed by the RPR. All cable markers and splice markers shall be painted international orange. Paint shall be specifically manufactured for uncured exterior concrete. After placement, all cable or splice markers shall be given one coat of high-visibility aviation orange paint as approved by the RPR. Furnishing and installation of cable markers is incidental to the respective cable pay item.

108-3.5 Splicing. Connections of the type shown on the plans shall be made by experienced personnel regularly engaged in this type of work and shall be made as follows:

a. Cast splices. These shall be made by using crimp connectors for jointing conductors. Molds shall be assembled, and the compound shall be mixed and poured per the manufacturer's instructions and to the satisfaction of the RPR.

b. Field-attached plug-in splices. These shall be assembled per the manufacturer's instructions. These splices shall be made by plugging directly into mating connectors. The joint where the connectors come together shall be finished by one of the following methods: (1) wrapped with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half lapped, extending at least 1-1/2 inches (38 mm) on each side of the joint (2) Covered with heat shrinkable tubing with integral sealant extending at least 1-1/2 inches (38 mm) on each side of the joint or (3) On connector kits equipped with water seal flap; roll-over water seal flap to sealing position on mating connector.

c. Factory-molded plug-in splices. These shall be made by plugging directly into mating connectors. The joint where the connectors come together shall be finished by one of the following methods: (1) Wrapped with at least one layer of rubber or synthetic rubber tape and one layer of plastic tape, one-half

lapped, extending at least 1-1/2 inches (38 mm) on each side of the joint. (2) Covered with heat shrinkable tubing with integral sealant extending at least 1-1/2 inches (38 mm) on each side of the joint. or (3) On connector kits so equipped with water seal flap; roll-over water seal flap to sealing position on mating connector.

d. Taped or heat-shrink splices. A taped splice shall be made in the following manner:

Bring the cables to their final position and cut so that the conductors will butt. Remove insulation and jacket allowing for bare conductor of proper length to fit compression sleeve connector with 1/4 inch (6 mm) of bare conductor on each side of the connector. Prior to splicing, the two ends of the cable insulation shall be penciled using a tool designed specifically for this purpose and for cable size and type. Do not use emery paper on splicing operation since it contains metallic particles. The copper conductors shall be thoroughly cleaned. Join the conductors by inserting them equidistant into the compression connection sleeve. Crimp conductors firmly in place with crimping tool that requires a complete crimp before tool can be removed. Test the crimped connection by pulling on the cable. Scrape the insulation to assure that the entire surface over which the tape will be applied (plus 3 inches (75 mm) on each end) is clean. After scraping, wipe the entire area with a clean lint-free cloth. Do not use solvents.

Apply high-voltage rubber tape one-half lapped over bare conductor. This tape should be tensioned as recommended by the manufacturer. Voids in the connector area may be eliminated by highly elongating the tape, stretching it just short of its breaking point. The manufacturer's recommendation for stretching tape during splicing shall be followed. Always attempt to exactly half-lap to produce a uniform buildup. Continue buildup to 1-1/2 times cable diameter over the body of the splice with ends tapered a distance of approximately one inch (25 mm) over the original jacket. Cover rubber tape with two layers of vinyl pressure-sensitive tape one-half lapped. Do not use glyptol or lacquer over vinyl tape as they react as solvents to the tape. No further cable covering or splice boxes are required.

Heat shrinkable tubing shall be installed following manufacturer’s instructions. Direct flame heating shall not be permitted unless recommended by the manufacturer. Cable surfaces within the limits of the heat-shrink application shall be clean and free of contaminates prior to application.

e. Assembly. Surfaces of equipment or conductors being terminated or connected shall be prepared in accordance with industry standard practice and manufacturer’s recommendations. All surfaces to be connected shall be thoroughly cleaned to remove all dirt, grease, oxides, nonconductive films, or other foreign material. Paints and other nonconductive coatings shall be removed to expose base metal. Clean all surfaces at least 1/4 inch (6.4 mm) beyond all sides of the larger bonded area on all mating surfaces. Use a joint compound suitable for the materials used in the connection. Repair painted/coated surface to original condition after completing the connection.

108-3.6 Bare counterpoise wire installation for lightning protection and grounding. If shown on the plans or included in the job specifications, bare solid **[** #6 AWG **]** copper counterpoise wire shall be installed for lightning protection of the underground cables. The RPR shall select one of two methods of lightning protection for the airfield lighting circuit based upon sound engineering practice and lightning strike density.

a. Equipotential. The counterpoise size is as shown on the plans. The equipotential method is applicable to all airfield lighting systems; i.e. runway, taxiway, apron – touchdown zone, centerline, edge, threshold and approach lighting systems. The equipotential method is also successfully applied to provide lightning protection for power, signal and communication systems. The light bases, counterpoise, etc – all components - are bonded together and bonded to the vault power system ground loop/electrode.

Counterpoise wire shall be installed in the same trench for the entire length of buried cable, conduits and duct banks that are installed to contain airfield cables. The counterpoise is centered over the cable/conduit/duct to be protected.

The counterpoise conductor shall be installed no less than 8 inches (200 mm) minimum or 12 inches (300 mm) maximum above the raceway or cable to be protected, except as permitted below:

(1) The minimum counterpoise conductor height above the raceway or cable to be protected shall be permitted to be adjusted subject to coordination with the airfield lighting and pavement designs.

(2) The counterpoise conductor height above the protected raceway(s) or cable(s) shall be calculated to ensure that the raceway or cable is within a 45-degree area of protection, (45 degrees on each side of vertical creating a 90 degree angle).

The counterpoise conductor shall be bonded to each metallic light base, mounting stake, and metallic airfield lighting component.

All metallic airfield lighting components in the field circuit on the output side of the constant current regulator (CCR) or other power source shall be bonded to the airfield lighting counterpoise system.

All components rise and fall at the same potential; with no potential difference, no damaging arcing and no damaging current flow.

See AC 150/5340-30, Design and Installation Details for Airport Visual Aids and NFPA 780, Standard for the Installation of Lightning Protection Systems, Chapter 11, for a detailed description of the Equipotential Method of lightning protection.

Reference FAA STD-019E, Lightning and Surge Protection, Grounding Bonding and Shielding Requirements for Facilities and Electronic Equipment, Part 4.1.1.7.][not used]

b. Isolation. Counterpoise size is as shown on the plans. The isolation method is an alternate method for use only with edge lights installed in turf and stabilized soils and raceways installed parallel to and adjacent to the edge of the pavement. NFPA 780 uses 15 feet to define “adjacent to”.

The counterpoise conductor shall be installed halfway between the pavement edge and the light base, mounting stake, raceway, or cable being protected.

The counterpoise conductor shall be installed 8 inches (203 mm) minimum below grade. The counterpoise is not connected to the light base or mounting stake. An additional grounding electrode is required at each light base or mounting stake. The grounding electrode is bonded to the light base or mounting stake with a 6 AWG solid copper conductor.

See AC 150/5340-30, Design and Installation Details for Airport Visual Aids and NFPA 780, Standard for the Installation of Lightning Protection Systems, Chapter 11, for a detailed description of the Isolation Method of lightning protection.][not used]

c. Common Installation requirements. When a metallic light base is used, the grounding electrode shall be bonded to the metallic light base or mounting stake with a No. 6 AWG bare, annealed or soft drawn, solid copper conductor.

When a nonmetallic light base is used, the grounding electrode shall be bonded to the metallic light fixture or metallic base plate with a No. 6 AWG bare, annealed or soft drawn, solid copper conductor.

Grounding electrodes may be rods, ground dissipation plates, radials, or other electrodes listed in the NFPA 70 (NEC) or NFPA 780.

Where raceway is installed by the directional bore, jack and bore, or other drilling method, the counterpoise conductor shall be permitted to be installed concurrently with the directional bore, jack and bore, or other drilling method raceway, external to the raceway or sleeve.

The counterpoise wire shall also be exothermically welded to ground rods installed as shown on the plans but not more than 500 feet (150 m) apart around the entire circuit. The counterpoise system shall be continuous and terminate at the transformer vault or at the power source. It shall be securely attached to

the vault or equipment external ground ring or other made electrode-grounding system. The connections shall be made as shown on the plans and in the specifications.

Where an existing airfield lighting system is being extended or modified, the new counterpoise conductors shall be interconnected to existing counterpoise conductors at each intersection of the new and existing airfield lighting counterpoise systems.

d. Parallel Voltage Systems. Provide grounding and bonding in accordance with NFPA 70, National Electrical Code.

108-3.7 Counterpoise installation above multiple conduits and duct banks. Counterpoise wires shall be installed above multiple conduits/duct banks for airfield lighting cables, with the intent being to provide a complete area of protection over the airfield lighting cables. When multiple conduits and/or duct banks for airfield cable are installed in the same trench, the number and location of counterpoise wires above the conduits shall be adequate to provide a complete area of protection measured 45 degrees each side of vertical.

Where duct banks pass under pavement to be constructed in the project, the counterpoise shall be placed above the duct bank. Reference details on the construction plans.

108-3.8 Counterpoise installation at existing duct banks. When airfield lighting cables are indicated on the plans to be routed through existing duct banks, the new counterpoise wiring shall be terminated at ground rods at each end of the existing duct bank where the cables being protected enter and exit the duct bank. The new counterpoise conductor shall be bonded to the existing counterpoise system.

108-3.9 Exothermic bonding. Bonding of counterpoise wire shall be by the exothermic welding process or equivalent method accepted by the RPR. Only personnel experienced in and regularly engaged in this type of work shall make these connections.

Contractor shall demonstrate to the satisfaction of the RPR, the welding kits, materials and procedures to be used for welded connections prior to any installations in the field. The installations shall comply with the manufacturer's recommendations and the following:

a. All slag shall be removed from welds.

b. Using an exothermic weld to bond the counterpoise to a lug on a galvanized light base is not recommended unless the base has been specially modified. Consult the manufacturer's installation directions for proper methods of bonding copper wire to the light base. See AC 150/5340-30 for galvanized light base exception.

c. If called for in the plans, all buried copper and weld material at weld connections shall be thoroughly coated with 6 mm of 3M™ Scotchkote™, or approved equivalent, or coated with coal tar Bitumastic® material to prevent surface exposure to corrosive soil or moisture.

108-3.10 Testing. The Contractor shall furnish all necessary equipment and appliances for testing the airport electrical systems and underground cable circuits before and after installation. The Contractor shall perform all tests in the presence of the RPR. The Contractor shall demonstrate the electrical characteristics to the satisfaction of the RPR. All costs for testing are incidental to the respective item being tested. For phased projects, the tests must be completed by phase. The Contractor must maintain the test results throughout the entire project as well as during the warranty period that meet the following:

a. Earth resistance testing methods shall be submitted to the RPR for approval. Earth resistance testing results shall be recorded on an approved form and testing shall be performed in the presence of the RPR. All such testing shall be at the sole expense of the Contractor.

b. Should the counterpoise or ground grid conductors be damaged or suspected of being damaged by construction activities the Contractor shall test the conductors for continuity with a low resistance ohmmeter. The conductors shall be isolated such that no parallel path exists and tested for continuity. The

RPR shall approve of the test method selected. All such testing shall be at the sole expense of the Contractor.

After installation, the Contractor shall test and demonstrate to the satisfaction of the RPR the following:

c. That all affected lighting power and control circuits (existing and new) are continuous and free from short circuits.

d. That all affected circuits (existing and new) are free from unspecified grounds.

e. That the insulation resistance to ground of all new non-grounded high voltage series circuits or cable segments is not less than **[___]** megohms. Verify continuity of all series airfield lighting circuits prior to energization.

f. That the insulation resistance to ground of all new non-grounded conductors of new multiple circuits or circuit segments is not less than 100 megohms.

g. That all affected circuits (existing and new) are properly connected per applicable wiring diagrams.

h. That all affected circuits (existing and new) are operable. Tests shall be conducted that include operating each control not less than 10 times and the continuous operation of each lighting and power circuit for not less than 1/2 hour.

i. That the impedance to ground of each ground rod does not exceed **[___]** ohms prior to establishing connections to other ground electrodes. The fall-of-potential ground impedance test shall be used, as described by American National Standards Institute/Institute of Electrical and Electronic Engineers (ANSI/IEEE) Standard 81, to verify this requirement. As an alternate, clamp-on style ground impedance test meters may be used to satisfy the impedance testing requirement. Test equipment and its calibration sheets shall be submitted for review and approval by the RPR prior to performing the testing.

Two copies of tabulated results of all cable tests performed shall be supplied by the Contractor to the RPR. Where connecting new cable to existing cable, insulation resistance tests shall be performed on the new cable prior to connection to the existing circuit.

There are no approved “repair” procedures for items that have failed testing other than complete replacement.

METHOD OF MEASUREMENT

108-4.1 Underground Power Cable for Airports shall be measured based on the percentage of work completed of the contract lump sum as determined by the RPR.

BASIS OF PAYMENT

108-5.1 Underground Power Cable for Airports will be paid for as a percentage of the contract lump sum based on the work completed as determined by the RPR.

Payment will be made under:

Item L-108	Underground Power Cable for Airports

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

Advisory Circulars (AC)

AC 150/5340-26	Maintenance of Airport Visual Aid Facilities
AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-26	Specification for L-823 Plug and Receptacle, Cable Connectors
AC 150/5345-53	Airport Lighting Equipment Certification Program

Commercial Item Description

A-A-59544A	Cable and Wire, Electrical (Power, Fixed Installation)
A-A-55809	Insulation Tape, Electrical, Pressure-Sensitive Adhesive, Plastic

ASTM International (ASTM)

ASTM B3	Standard Specification for Soft or Annealed Copper Wire
ASTM B8	Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
ASTM B33	Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes
ASTM D4388	Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes

Mil Spec

MIL-PRF-23586F	Performance Specification: Sealing Compound (with Accelerator), Silicone Rubber, Electrical
MIL-I-24391	Insulation Tape, Electrical, Plastic, Pressure Sensitive

National Fire Protection Association (NFPA)

NFPA-70	National Electrical Code (NEC)
NFPA-780	Standard for the Installation of Lightning Protection Systems

American National Standards Institute (ANSI)/Institute of Electrical and Electronics Engineers (IEEE)

ANSI/IEEE STD 81	IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

Federal Aviation Administration Standard

FAA STD-019E	Lightning and Surge Protection, Grounding Bonding and Shielding Requirements for Facilities and Electronic Equipment

END OF ITEM L-108

Item L-110 Airport Underground Electrical Duct Banks and Conduits

DESCRIPTION

110-1.1 This item shall consist of underground electrical conduits and duct banks (single or multiple conduits encased in concrete or buried in sand) installed per this specification at the locations and per the dimensions, designs, and details shown on the plans. This item shall include furnishing and installing of all underground electrical duct banks and individual and multiple underground conduits and removal of existing duct banks. It shall also include all turfing trenching, backfilling, removal, and restoration of any paved or turfed areas; concrete encasement, mandrelling, pulling lines, duct markers, plugging of conduits, and the testing of the installation as a completed system ready for installation of cables per the plans and specifications. This item shall also include furnishing and installing conduits and all incidentals for providing positive drainage of the system. Verification of existing ducts is incidental to the pay items provided in this specification.

EQUIPMENT AND MATERIALS

110-2.1 General.

a. All equipment and materials covered by referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when requested by the RPR.

b. Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications and acceptable to the RPR. Materials supplied and/or installed that do not comply with these specifications shall be removed, when directed by the RPR and replaced with materials, that comply with these specifications, at the Contractor's cost.

c. All materials and equipment used to construct this item shall be submitted to the RPR for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment for which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in project that accrue directly or indirectly from late submissions or resubmissions of submittals.

d. The data submitted shall be sufficient, in the opinion of the RPR, to determine compliance with the plans and specifications. The Contractor's submittals shall be electronically submitted in pdf format, tabbed by specification section. The RPR reserves the right to reject any and all equipment, materials or procedures that do not meet the system design and the standards and codes specified in this document.

e. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of at least twelve (12) months from final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner.

110-2.2 Steel conduit. Rigid galvanized steel (RGS) conduit and fittings shall be hot dipped galvanized inside and out and conform to the requirements of Underwriters Laboratories Standards 6, 514B, and 1242. All RGS conduits or RGS elbows installed below grade, in concrete, permanently wet locations or other similar environments shall be painted with a 10-mil thick coat of asphaltum sealer or shall have a factory-bonded polyvinyl chloride (PVC) cover. Any exposed galvanizing or steel shall be coated with 10 mils of asphaltum sealer. When using PVC coated RGS conduit, care shall be exercised not to damage the factory PVC coating. Damaged PVC coating shall be repaired per the manufacturer's written instructions. In lieu of PVC coated RGS, corrosion wrap tape shall be permitted to be used where RGS is in contact with direct earth."

110-2.3 Plastic conduit. Plastic conduit and fittings-shall conform to the following requirements:

- UL 514B covers W-C-1094-Conduit fittings all types, classes 1 thru 3 and 6 thru 10.
- UL 514C covers W-C-1094- all types, Class 5 junction box and cover in plastic (PVC).
- UL 651 covers W-C-1094-Rigid PVC Conduit, types I and II, Class 4.
- UL 651A covers W-C-1094-Rigid PVC Conduit and high-density polyethylene (HDPE) Conduit type III and Class 4.

Underwriters Laboratories Standards UL-651 and Article 352 of the current National Electrical Code shall be one of the following, as shown on the plans:

a. Type I–Schedule 40 and Schedule 80 PVC suitable for underground use either direct-buried or encased in concrete.

b. Type II–Schedule 40 PVC suitable for either above ground or underground use.

c. Type III – Schedule 80 PVC suitable for either above ground or underground use either direct-buried or encased in concrete.

d. Type III –HDPE pipe, minimum standard dimensional ratio (SDR) 11, suitable for placement with directional boring under pavement.

The type of solvent cement shall be as recommended by the conduit/fitting manufacturer.

110-2.4 Split conduit. Split conduit shall be pre-manufactured for the intended purpose and shall be made of steel or plastic.

110-2.5 Conduit spacers. Conduit spacers shall be prefabricated interlocking units manufactured for the intended purpose. They shall be of double wall construction made of high grade, high density polyethylene complete with interlocking cap and base pads. They shall be designed to accept No. 4 reinforcing bars installed vertically.

110-2.6 Concrete. Concrete shall be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures.

110-2.7 Precast concrete structures. Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or another RPR approved third party certification program. Precast concrete structures shall conform to ASTM C478.

110-2.8 Flowable backfill. Flowable material used to back fill conduit and duct bank trenches shall conform to the requirements of Item P-153, Controlled Low Strength Material.

110-2.9 Detectable warning tape. Plastic, detectable, American Public Works Association (APWA) red (electrical power lines, cables, conduit and lighting cable), orange (telephone/fiber optic cabling) with

continuous legend magnetic tape shall be polyethylene film with a metallized foil core and shall be 3-6 inches (75-150 mm) wide. Detectable tape is incidental to the respective bid item.

CONSTRUCTION METHODS

110-3.1 General. The Contractor shall install underground duct banks and conduits at the approximate locations indicated on the plans. The RPR shall indicate specific locations as the work progresses, if required to differ from the plans. Duct banks and conduits shall be of the size, material, and type indicated on the plans or specifications. Where no size is indicated on the plans or in the specifications, conduits shall be not less than 2 inches (50 mm) inside diameter or comply with the National Electrical Code based on cable to be installed, whichever is larger. All duct bank and conduit lines shall be laid so as to grade toward access points and duct or conduit ends for drainage. Unless shown otherwise on the plans, grades shall be at least 3 inches (75 mm) per 100 feet (30 m). On runs where it is not practicable to maintain the grade all one way, the duct bank and conduit lines shall be graded from the center in both directions toward access points or conduit ends, with a drain into the storm drainage system. Pockets or traps where moisture may accumulate shall be avoided. Under pavement, the top of the duct bank shall not be less than 18 inches (0.5 m) below the subgrade; in other locations, the top of the duct bank or underground conduit shall be be not less than 18 inches (0.5 m) below finished grade.

The Contractor shall mandrel each individual conduit whether the conduit is direct-buried or part of a duct bank. An iron-shod mandrel, not more than 1/4 inch (6 mm) smaller than the bore of the conduit shall be pulled or pushed through each conduit. The mandrel shall have a leather or rubber gasket slightly larger than the conduit hole.

The Contractor shall swab out all conduits/ducts and clean base can, manhole, pull boxes, etc., interiors immediately prior to pulling cable. Once cleaned and swabbed the light bases, manholes, pull boxes, etc., and all accessible points of entry to the duct/conduit system shall be kept closed except when installing cables. Cleaning of ducts, base cans, manholes, etc., is incidental to the pay item of the item being cleaned. All raceway systems left open, after initial cleaning, for any reason shall be recleaned at the Contractor’s expense. All accessible points shall be kept closed when not installing cable. The Contractor shall verify existing ducts proposed for use in this project as clear and open. The Contractor shall notify the RPR of any blockage in the existing ducts.

For pulling the permanent wiring, each individual conduit, whether the conduit is direct-buried or part of a duct bank, shall be provided with a 200-pound (90 kg) test polypropylene pull rope. The ends shall be secured and sufficient length shall be left in access points to prevent it from slipping back into the conduit. Where spare conduits are installed, as indicated on the plans, the open ends shall be plugged with removable tapered plugs, designed for this purpose.

All conduits shall be securely fastened in place during construction and shall be plugged to prevent contaminants from entering the conduits. Any conduit section having a defective joint shall not be installed. Ducts shall be supported and spaced apart using approved spacers at intervals not to exceed 5 feet (1.5 m).

Unless otherwise shown on the plans, concrete encased duct banks shall be used when crossing under pavements expected to carry aircraft loads, such as runways, taxiways, taxilanes, ramps and aprons. When under paved shoulders and other paved areas, conduit and duct banks shall be encased using flowable fill for protection.

All conduits within concrete encasement of the duct banks shall terminate with female ends for ease in current and future use. Install factory plugs in all unused ends. Do not cover the ends or plugs with concrete.

Where turf is well established and the sod can be removed, it shall be carefully stripped and properly stored.

Trenches for conduits and duct banks may be excavated manually or with mechanical trenching equipment unless in pavement, in which case they shall be excavated with mechanical trenching equipment. Walls of trenches shall be essentially vertical so that a minimum of shoulder surface is disturbed. Blades of graders shall not be used to excavate the trench.

When rock is encountered, the rock shall be removed to a depth of at least 3 inches (75 mm) below the required conduit or duct bank depth and it shall be replaced with bedding material of earth or sand containing no mineral aggregate particles that would be retained on a 1/4-inch (6.3 mm) sieve. Flowable backfill may alternatively be used

Underground electrical warning (Caution) tape shall be installed in the trench above all underground duct banks and conduits in unpaved areas. Contractor shall submit a sample of the proposed warning tape for approval by the RPR. If not shown on the plans, the warning tape shall be located 6 inches above the duct/conduit or the counterpoise wire if present.

Joints in plastic conduit shall be prepared per the manufacturer's recommendations for the particular type of conduit. Plastic conduit shall be prepared by application of a plastic cleaner and brushing a plastic solvent on the outside of the conduit ends and on the inside of the couplings. The conduit fitting shall then be slipped together with a quick one-quarter turn twist to set the joint tightly. Where more than one conduit is placed in a single trench, or in duct banks, joints in the conduit shall be staggered a minimum of 2 feet (60 cm).

Changes in direction of runs exceeding 10 degrees, either vertical or horizontal, shall be accomplished using manufactured sweep bends.

Whether or not specifically indicated on the drawings, where the soil encountered at established duct bank grade is an unsuitable material, as determined by the RPR, the unsuitable material shall be removed per Item P-152 and replaced with suitable material. Additional duct bank supports shall be installed, as approved by the RPR.

All excavation shall be unclassified and shall be considered incidental to Item L-110. Dewatering necessary for duct installation, and erosion per federal, state, and local requirements is incidental to Item L-110.

Unless otherwise specified, excavated materials that are deemed by the RPR to be unsuitable for use in backfill or embankments shall be removed and disposed of offsite.

Any excess excavation shall be filled with suitable material approved by the RPR and compacted per Item P-152.

It is the Contractor's responsibility to locate existing utilities within the work area prior to excavation. Where existing active cables) cross proposed installations, the Contractor shall ensure that these cables are adequately protected. Where crossings are unavoidable, no splices will be allowed in the existing cables, except as specified on the plans. Installation of new cable where such crossings must occur shall proceed as follows:

a. Existing cables shall be located manually. Unearthed cables shall be inspected to assure absolutely no damage has occurred

b. Trenching, etc., in cable areas shall then proceed with approval of the RPR, with care taken to minimize possible damage or disruption of existing cable, including careful backfilling in area of cable.

In the event that any previously identified cable is damaged during the course of construction, the Contractor shall be responsible for the complete repair.

110-3.2 Duct banks. Unless otherwise shown in the plans, duct banks shall be installed so that the top of the concrete envelope is not less than 18 inches (0.5 m) below the bottom of the base or stabilized base course layers where installed under runways, taxiways, aprons, or other paved areas, and not less than 18 inches (0.5 m) below finished grade where installed in unpaved areas.

Unless otherwise shown on the plans, duct banks under paved areas shall extend at least 3 feet (1 m) beyond the edges of the pavement or 3 feet (1 m) beyond any under drains that may be installed alongside the paved area. Trenches for duct banks shall be opened the complete length before concrete is placed so that if any obstructions are encountered, provisions can be made to avoid them. Unless otherwise shown on the plans, all duct banks shall be placed on a layer of concrete not less than 3 inches (75 mm) thick prior to its initial set. The Contractor shall space the conduits not less than 3 inches (75 mm) apart (measured from outside wall to outside wall). All such multiple conduits shall be placed using conduit spacers applicable to the type of conduit. As the conduit laying progresses, concrete shall be placed around and on top of the conduits not less than 3 inches (75 mm) thick unless otherwise shown on the plans. All conduits shall terminate with female ends for ease of access in current and future use. Install factory plugs in all unused ends. Do not cover the ends or plugs with concrete.

Conduits forming the duct bank shall be installed using conduit spacers. No. 4 reinforcing bars shall be driven vertically into the soil a minimum of 6 inches (150 mm) to anchor the assembly into the earth prior to placing the concrete encasement. For this purpose, the spacers shall be fastened down with locking collars attached to the vertical bars. Spacers shall be installed at 5-foot (1.5-m) intervals. Spacers shall be in the proper sizes and configurations to fit the conduits. Locking collars and spacers shall be submitted to the RPR for review prior to use.

When specified, the Contractor shall reinforce the bottom side and top of encasements with steel reinforcing mesh or fabric or other approved metal reinforcement. When directed, the Contractor shall supply additional supports where the ground is soft and boggy, where ducts cross under roadways, or where shown on the plans. Under such conditions, the complete duct structure shall be supported on reinforced concrete footings, piers, or piles located at approximately 5-foot (1.5-m) intervals.

All pavement surfaces that are to have ducts installed therein shall be neatly saw cut to form a vertical face. All excavation shall be included in the contract with price for the duct.

Install a plastic, detectable, color as noted, 3 to 6 inches (75 to 150 mm) wide tape, 8 inches (200 mm) minimum below grade above all underground conduit or duct lines not installed under pavement. Utilize the 3-inch (75-mm) wide tape only for single conduit runs. Utilize the 6-inch (150-mm) wide tape for multiple conduits and duct banks. For duct banks equal to or greater than 24 inches (600 mm) in width, utilize more than one tape for sufficient coverage and identification of the duct bank as required.

When existing cables are to be placed in split duct, encased in concrete, the cable shall be carefully located and exposed by hand tools. Prior to being placed in duct, the RPR shall be notified so that he may inspect the cable and determine that it is in good condition. Where required, split duct shall be installed as shown on the drawings or as required by the RPR.

110-3.3 Conduits without concrete encasement. Trenches for single-conduit lines shall be not less than 6 inches (150 mm) nor more than 12 inches (300 mm) wide. The trench for 2 or more conduits installed at the same level shall be proportionately wider. Trench bottoms for conduits without concrete encasement shall be made to conform accurately to grade so as to provide uniform support for the conduit along its entire length.

Unless otherwise shown on the plans, a layer of fine earth material, at least 4 inches (100 mm) thick (loose measurement) shall be placed in the bottom of the trench as bedding for the conduit. The bedding material shall consist of soft dirt, sand or other fine fill, and it shall contain no particles that would be retained on a 1/4-inch (6.3 mm) sieve. The bedding material shall be tamped until firm. Flowable backfill may alternatively be used.

Unless otherwise shown on plans, conduits shall be installed so that the tops of all conduits within the Airport's secured area where trespassing is prohibited are at least 18 inches (0.5 m) below the finished grade. Conduits outside the Airport's secured area shall be installed so that the tops of the conduits are at least 24 inches (60 cm) below the finished grade per National Electric Code (NEC), Table 300.5.

When two or more individual conduits intended to carry conductors of equivalent voltage insulation rating are installed in the same trench without concrete encasement, they shall be spaced not less than 3 inches (75 mm) apart (measured from outside wall to outside wall) in a horizontal direction and not less than 6 inches (150 mm) apart in a vertical direction. Where two or more individual conduits intended to carry conductors of differing voltage insulation rating are installed in the same trench without concrete encasement, they shall be placed not less than 3 inches (75 mm) apart (measured from outside wall to outside wall) in a horizontal direction and lot less than 6 inches (150 mm) apart in a vertical direction.

Trenches shall be opened the complete length between normal termination points before conduit is installed so that if any unforeseen obstructions are encountered, proper provisions can be made to avoid them.

Conduits shall be installed using conduit spacers. No. 4 reinforcing bars shall be driven vertically into the soil a minimum of 6 inches (150 mm) to anchor the assembly into the earth while backfilling. For this purpose, the spacers shall be fastened down with locking collars attached to the vertical bars. Spacers shall be installed at 5-foot (1.5-m) intervals. Spacers shall be in the proper sizes and configurations to fit the conduits. Locking collars and spacers shall be submitted to the RPR for review prior to use.

110-3.4 Markers. The location of each end and of each change of direction of conduits and duct banks shall be marked by a concrete slab marker 2 feet (60 cm) square and 4 - 6 inches (100 - 150 mm) thick extending approximately one inch (25 mm) above the surface. The markers shall also be located directly above the ends of all conduits or duct banks, except where they terminate in a junction/access structure or building. Each cable or duct run from a line of lights and signs to the equipment vault must be marked at approximately every 200 feet (61 m) along the cable or duct run, with an additional marker at each change of direction of cable or duct run.

The Contractor shall impress the word "DUCT" or "CONDUIT" on each marker slab. Impression of letters shall be done in a manner, approved by the RPR, for a neat, professional appearance. All letters and words must be neatly stenciled. After placement, all markers shall be given one coat of high-visibility orange paint, as approved by the RPR. The Contractor shall also impress on the slab the number and size of conduits beneath the marker along with all other necessary information as determined by the RPR. The letters shall be 4 inches (100 mm) high and 3 inches (75 mm) wide with width of stroke 1/2 inch (12 mm) and 1/4 inch (6 mm) deep or as large as the available space permits. Furnishing and installation of duct markers is incidental to the respective duct pay item.

110-3.5 Backfilling for conduits. For conduits, 8 inches (200 mm) of sand, soft earth, or other fine fill (loose measurement) shall be placed around the conduits ducts and carefully tamped around and over them with hand tampers. The remaining trench shall then be backfilled and compacted per Item P-152 except that material used for back fill shall be select material not larger than 4 inches (100 mm) in diameter.

Flowable backfill may alternatively be used.

Trenches shall not contain pools of water during back filling operations.

The trench shall be completely backfilled and tamped level with the adjacent surface; except that, where sod is to be placed over the trench, the backfilling shall be stopped at a depth equal to the thickness of the sod to be used, with proper allowance for settlement.

Any excess excavated material shall be removed and disposed of per instructions issued by the RPR.

110-3.6 Backfilling for duct banks. After the concrete has cured, the remaining trench shall be backfilled and compacted per Item P-152 "Excavation and Embankment" except that the material used for backfill shall be select material not larger than 4 inches (100 mm) in diameter. In addition to the requirements of Item P-152, where duct banks are installed under pavement, one moisture/density test per lift shall be made for each 250 linear feet (76 m) of duct bank or one work period's construction, whichever is less.

Flowable backfill may alternatively be used.

Trenches shall not contain pools of water during backfilling operations.

The trench shall be completely backfilled and tamped level with the adjacent surface; except that, where sod is to be placed over the trench, the backfilling shall be stopped at a depth equal to the thickness of the sod to be used, with proper allowance for settlement.

Any excess excavated material shall be removed and disposed of per instructions issued by the RPR.

110-3.7 Restoration. Where sod has been removed, it shall be replaced as soon as possible after the backfilling is completed. All areas disturbed by the work shall be restored to its original condition. The restoration shall include topsoiling, fertilizing, seeding, and mulching shown on the plans. The Contractor shall be held responsible for maintaining all disturbed surfaces and replacements until final acceptance. All restoration shall be considered incidental to the respective L-110 pay item. Following restoration of all trenching near airport movement surfaces, the Contractor shall thoroughly visually inspect the area for foreign object debris (FOD), and remove any such FOD that is found. This FOD inspection and removal shall be considered incidental to the pay item of which it is a component part.

110-3.8 Ownership of removed cable. The Contractor will dispose of all cable off Airport property unless directed otherwise by the RPR.

METHOD OF MEASUREMENT

110-4.1 Airport Underground Electrical Duct Banks and Conduits shall be measured based on the percentage of work completed of the contract lump sum as determined by the RPR.

BASIS OF PAYMENT

110-5.1 Airport Underground Electrical Duct Banks and Conduits will be paid for as a percentage of the contract lump sum based on the work completed as determined by the RPR.

Payment will be made under:

Item L-110	Airport Underground Electrical Duct Banks and Conduits

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

Advisory Circular (AC)

AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-53	Airport Lighting Equipment Certification Program

ASTM International (ASTM)

ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement

National Fire Protection Association (NFPA)

NFPA-70	National Electrical Code (NEC)

Underwriters Laboratories (UL)

UL Standard 6	Electrical Rigid Metal Conduit - Steel
UL Standard 514B	Conduit, Tubing, and Cable Fittings
UL Standard 514C	Nonmetallic Outlet Boxes, Flush-Device Boxes, and Covers
UL Standard 1242	Electrical Intermediate Metal Conduit Steel
UL Standard 651	Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings
UL Standard 651A	Type EB and A Rigid PVC Conduit and HDPE Conduit

END OF ITEM L-110

Item L-115 Electrical Manholes and Junction Structures

DESCRIPTION

115-1.1 This item shall consist of electrical manholes and junction structures (hand holes, pull boxes, junction cans, etc.) installed per this specification, at the indicated locations and conforming to the lines, grades and dimensions shown on the plans or as required by the RPR. This item shall include the installation of each electrical manhole and/or junction structures with all associated excavation, backfilling, sheeting and bracing, concrete, reinforcing steel, ladders, appurtenances, testing, dewatering and restoration of surfaces to the satisfaction of the RPR including removal of existing manholes and junction structures as shown on the plans.

EQUIPMENT AND MATERIALS

115-2.1 General.

a. All equipment and materials covered by referenced specifications shall be subject to acceptance through manufacturer's certification of compliance with the applicable specification when so requested by the RPR.

b. Manufacturer's certifications shall not relieve the Contractor of the responsibility to provide materials per these specifications. Materials supplied and/or installed that do not comply with these specifications shall be removed (when directed by the RPR) and replaced with materials that comply with these specifications at the Contractor's cost.

c. All materials and equipment used to construct this item shall be submitted to the RPR for approval prior to ordering the equipment. Submittals consisting of marked catalog sheets or shop drawings shall be provided. Submittal data shall be presented in a clear, precise and thorough manner. Original catalog sheets are preferred. Photocopies are acceptable provided they are as good a quality as the original. Clearly and boldly mark each copy to identify products or models applicable to this project. Indicate all optional equipment and delete any non-pertinent data. Submittals for components of electrical equipment and systems shall identify the equipment to which they apply on each submittal sheet. Markings shall be made bold and clear with arrows or circles (highlighting is not acceptable). The Contractor is solely responsible for delays in the project that may accrue directly or indirectly from late submissions or resubmissions of submittals.

d. The data submitted shall be sufficient, in the opinion of the RPR, to determine compliance with the plans and specifications**.** The Contractor's submittals shall be electronically submitted in pdf format, tabbed by specification section. The RPR reserves the right to reject any and all equipment, materials or procedures that do not meet the system design and the standards and codes, specified in this document.

e. All equipment and materials furnished and installed under this section shall be guaranteed against defects in materials and workmanship for a period of at least twelve (12) months from the date of final acceptance by the Owner. The defective materials and/or equipment shall be repaired or replaced, at the Owner's discretion, with no additional cost to the Owner.

115-2.2 Concrete structures. Concrete shall be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures. Cast-in-place concrete structures shall be as shown on the plans.

115-2.3 Precast concrete structures. Precast concrete structures shall be furnished by a plant meeting National Precast Concrete Association Plant Certification Program or another engineer approved third party certification program. Provide precast concrete structures where shown on the plans.

Precast concrete structures shall be an approved standard design of the manufacturer. Precast units shall have mortar or bitumastic sealer placed between all joints to make them watertight. The structure shall be designed to withstand 60,000 lb aircraft loads, unless otherwise shown on the plans. Openings or knockouts shall be provided in the structure as detailed on the plans.

Threaded inserts and pulling eyes shall be cast in as shown on the plans.

If the Contractor chooses to propose a different structural design, signed and sealed shop drawings, design calculations, and other information requested by the RPR shall be submitted by the Contractor to allow for a full evaluation by the RPR. The RPR shall review per the process defined in the General Provisions.

115-2.4 Junction boxes. Junction boxes shall be L-867 Class 1 (non-load bearing) or L-868 Class 1 (load bearing) airport light bases that are encased in concrete. The light bases shall have a L-894 blank cover, gasket, and stainless steel hardware. All bolts, studs, nuts, lock washers, and other similar fasteners used for the light fixture assemblies must be fabricated from 316L (equivalent to EN 1.4404), 18-8, 410, or 416 stainless steel. If 18-8, 410, or 416 stainless steel is utilized it shall be passivated and be free from any discoloration. Covers shall be 3/8-inch (9-mm) thickness for L-867 and 3/4-inch (19-mm) thickness for L-868. All junction boxes shall be provided with both internal and external ground lugs.

115-2.5 Mortar. The mortar shall be composed of one part of cement and two parts of mortar sand, by volume. The cement shall be per the requirements in ASTM C150, Type I. The sand shall be per the requirements in ASTM C144. Hydrated lime may be added to the mixture of sand and cement in an amount not to exceed 15% of the weight of cement used. The hydrated lime shall meet the requirements of ASTM C206. Water shall be potable, reasonably clean and free of oil, salt, acid, alkali, sugar, vegetable, or other substances injurious to the finished product.

115-2.6 Concrete. Concrete shall be proportioned, placed, and cured per Item P-610, Concrete for Miscellaneous Structures.

115-2.7 Frames and covers. The frames shall conform to one of the following requirements:

a. ASTM A48 Gray iron castings

b. ASTM A47 Malleable iron castings

c. ASTM A27 Steel castings

d. ASTM A283, Grade D Structural steel for grates and frames

e. ASTM A536 Ductile iron castings

f. ASTM A897 Austempered ductile iron castings

All castings specified shall be AASHTO H-20 load rated unless noted otherwise on the plans.

All castings or structural steel units shall conform to the dimensions shown on the plans and shall be designed to support the loadings specified.

Each frame and cover unit shall be provided with fastening members to prevent it from being dislodged by traffic, but which will allow easy removal for access to the structure.

All castings shall be thoroughly cleaned. After fabrication, structural steel units shall be galvanized to meet the requirements of ASTM A123.

Each cover shall have the word "ELECTRIC" or other approved designation cast on it. Each frame and cover shall be as shown on the plans or approved equivalent. No cable notches are required.

Each manhole shall be provided with a "DANGER -- PERMIT-REQUIRED CONFINED SPACE, DO NOT ENTER" safety warning sign as detailed in the Contract Documents and in accordance with OSHA 1910.146 (c)(2).

115-2.8 Ladders. Ladders, if specified, shall be galvanized steel or as shown on the plans.

115-2.9 Reinforcing steel. All reinforcing steel shall be deformed bars of new billet steel meeting the requirements of ASTM A615, Grade 60.

115-2.10 Bedding/special backfill. Bedding or special backfill shall be as shown on the plans.

115-2.11 Flowable backfill. Flowable material used to backfill shall conform to the requirements of Item P-153, Controlled Low Strength Material.

115-2.12 Cable trays. Cable trays shall be of galvanized steel. Cable trays shall be located as shown on the plans.

115-2.13 Plastic conduit. Plastic conduit shall comply with Item L-110, Airport Underground Electrical Duct Banks and Conduits.

115-2.14 Conduit terminators. Conduit terminators shall be pre-manufactured for the specific purpose and sized as required or as shown on the plans.

115-2.15 Pulling-in irons. Pulling-in irons shall be manufactured with 7/8-inch (22 mm) diameter hot-dipped galvanized steel or stress-relieved carbon steel roping designed for concrete applications (7 strand, 1/2-inch (12 mm) diameter with an ultimate strength of 270,000 psi (1862 MPa)). Where stress-relieved carbon steel roping is used, a rustproof sleeve shall be installed at the hooking point and all exposed surfaces shall be encapsulated with a polyester coating to prevent corrosion.

115-2.16 Ground rods. Ground rods shall be one piece, copper**.** The ground rods shall be of the length and diameter specified on the plans, but in no case shall they be less than 8 feet (2.4 m) long nor less than 5/8 inch (16 mm) in diameter.

CONSTRUCTION METHODS

115-3.1 Unclassified excavation. It is the Contractor's responsibility to locate existing utilities within the work area prior to excavation. Damage to utility lines, through lack of care in excavating, shall be repaired or replaced to the satisfaction of the RPR without additional expense to the Owner.

The Contractor shall perform excavation for structures and structure footings to the lines and grades or elevations shown on the plans or as staked by the RPR. The excavation shall be of sufficient size to permit the placing of the full width and length of the structure or structure footings shown.

All excavation shall be unclassified and shall be considered incidental to Item L-115. Dewatering necessary for structure installation and erosion per federal, state, and local requirements is incidental to Item L-115.

Boulders, logs and all other objectionable material encountered in excavation shall be removed. All rock and other hard foundation material shall be cleaned of all loose material and cut to a firm surface either level, stepped or serrated, as directed by the RPR. All seams, crevices, disintegrated rock and thin strata shall be removed. When concrete is to rest on a surface other than rock, special care shall be taken not to

disturb the bottom of the excavation. Excavation to final grade shall not be made until just before the concrete or reinforcing is to be placed.

The Contractor shall provide all bracing, sheeting and shoring necessary to implement and protect the excavation and the structure as required for safety or conformance to governing laws. The cost of bracing, sheeting and shoring shall be included in the unit price bid for the structure.

Unless otherwise provided, bracing, sheeting and shoring involved in the construction of this item shall be removed by the Contractor after the completion of the structure. Removal shall be effected in a manner that will not disturb or mar finished masonry. The cost of removal shall be included in the unit price bid for the structure.

After each excavation is completed, the Contractor shall notify the RPR. Structures shall be placed after the RPR has approved the depth of the excavation and the suitability of the foundation material.

Prior to installation the Contractor shall provide a minimum of 6 inches (150 mm) of sand or a material approved by the RPR as a suitable base to receive the structure. The base material shall be compacted and graded level and at proper elevation to receive the structure in proper relation to the conduit grade or ground cover requirements, as indicated on the plans.

115-3.2 Concrete structures. Concrete structures shall be built on prepared foundations conforming to the dimensions and form indicated on the plans. The concrete and construction methods shall conform to the requirements specified in Item P-610. Any reinforcement required shall be placed as indicated on the plans and shall be approved by the RPR before the concrete is placed.

115-3.3 Precast unit installations. Precast units shall be installed plumb and true. Joints shall be made watertight by use of sealant at each tongue-and-groove joint and at roof of manhole. Excess sealant shall be removed and severe surface projections on exterior of neck shall be removed.

115-3.4 Placement and treatment of castings, frames and fittings. All castings, frames and fittings shall be placed in the positions indicated on the Plans or as directed by the RPR and shall be set true to line and to correct elevation. If frames or fittings are to be set in concrete or cement mortar, all anchors or bolts shall be in place and position before the concrete or mortar is placed. The unit shall not be disturbed until the mortar or concrete has set.

Field connections shall be made with bolts, unless indicated otherwise. Welding will not be permitted unless shown otherwise on the approved shop drawings and written approval is granted by the casting manufacturer. Erection equipment shall be suitable and safe for the workman. Errors in shop fabrication or deformation resulting from handling and transportation that prevent the proper assembly and fitting of parts shall be reported immediately to the RPR and approval of the method of correction shall be obtained. Approved corrections shall be made at Contractor’s expense.

Anchor bolts and anchors shall be properly located and built into connection work. Bolts and anchors shall be preset by the use of templates or such other methods as may be required to locate the anchors and anchor bolts accurately.

Pulling-in irons shall be located opposite all conduit entrances into structures to provide a strong, convenient attachment for pulling-in blocks when installing cables. Pulling-in irons shall be set directly into the concrete walls of the structure.

115-3.5 Installation of ladders. Ladders shall be installed such that they may be removed if necessary. Mounting brackets shall be supplied top and bottom and shall be cast in place during fabrication of the structure or drilled and grouted in place after erection of the structure.

115-3.6 Removal of sheeting and bracing. In general, all sheeting and bracing used to support the sides of trenches or other open excavations shall be withdrawn as the trenches or other open excavations are being refilled. That portion of the sheeting extending below the top of a structure shall be withdrawn,

unless otherwise directed, before more than 6 inches (150 mm) of material is placed above the top of the structure and before any bracing is removed. Voids left by the sheeting shall be carefully refilled with selected material and rammed tight with tools especially adapted for the purpose or otherwise as may be approved.

The RPR may direct the Contractor to delay the removal of sheeting and bracing if, in his judgment, the installed work has not attained the necessary strength to permit placing of backfill.

115-3.7 Backfilling. After a structure has been completed, the area around it shall be backfilled in horizontal layers not to exceed 6 inches (150 mm) in thickness measured after compaction to the density requirements in Item P-152. Each layer shall be deposited all around the structure to approximately the same elevation. The top of the fill shall meet the elevation shown on the plans or as directed by the RPR.

Backfill shall not be placed against any structure until approval is given by the RPR. In the case of concrete, such approval shall not be given until tests made by the laboratory under supervision of the RPR establish that the concrete has attained sufficient strength to provide a factor of safety against damage or strain in withstanding any pressure created by the backfill or the methods used in placing it.

Where required, the RPR may direct the Contractor to add, at his own expense, sufficient water during compaction to assure a complete consolidation of the backfill. The Contractor shall be responsible for all damage or injury done to conduits, duct banks, structures, property or persons due to improper placing or compacting of backfill.

115-3.8 Connection of duct banks. To relieve stress of joint between concrete-encased duct banks and structure walls, reinforcement rods shall be placed in the structure wall and shall be formed and tied into duct bank reinforcement at the time the duct bank is installed.

115-3.9 Grounding. A ground rod shall be installed in the floor of all concrete structures so that the top of rod extends 6 inches (150 mm) above the floor. The ground rod shall be installed within one foot (30 cm) of a corner of the concrete structure. Ground rods shall be installed prior to casting the bottom slab. Where the soil condition does not permit driving the ground rod into the earth without damage to the ground rod, the Contractor shall drill a 4-inch (100 mm) diameter hole into the earth to receive the ground rod. The hole around the ground rod shall be filled throughout its length, below slab, with Portland cement grout. Ground rods shall be installed in precast bottom slab of structures by drilling a hole through bottom slab and installing the ground rod. Bottom slab penetration shall be sealed watertight with Portland cement grout around the ground rod.

A grounding bus of 4/0 bare stranded copper shall be exothermically bonded to the ground rod and loop the concrete structure walls. The ground bus shall be a minimum of one foot (30 cm) above the floor of the structure and separate from other cables. No. 2 American wire gauge (AWG) bare copper pigtails shall bond the grounding bus to all cable trays and other metal hardware within the concrete structure. Connections to the grounding bus shall be exothermic. If an exothermic weld is not possible, connections to the grounding bus shall be made by using connectors approved for direct burial in soil or concrete per UL 467. Hardware connections may be mechanical, using a lug designed for that purpose.

115-3.10 Cleanup and repair. After erection of all galvanized items, damaged areas shall be repaired by applying a liquid cold-galvanizing compound per MIL-P-21035. Surfaces shall be prepared and compound applied per the manufacturer’s recommendations.

Prior to acceptance, the entire structure shall be cleaned of all dirt and debris.

115-3.11 Restoration. After the backfill is completed, the Contractor shall dispose of all surplus material, dirt and rubbish from the site. The Contractor shall restore all disturbed areas equivalent to or better than their original condition. All sodding, grading and restoration shall be considered incidental to the respective Item L-115 pay item.

The Contractor shall grade around structures as required to provide positive drainage away from the structure.

Areas with special surface treatment, such as roads, sidewalks, or other paved areas shall have backfill compacted to match surrounding areas, and surfaces shall be repaired using materials comparable to original materials.

Following restoration of all trenching near airport movement surfaces, the Contractor shall thoroughly visually inspect the area for foreign object debris (FOD), and remove any such FOD that is found. This FOD inspection and removal shall be considered incidental to the pay item of which it is a component part.

After all work is completed, the Contractor shall remove all tools and other equipment, leaving the entire site free, clear and in good condition.

115-3.12 Inspection. Prior to final approval, the electrical structures shall be thoroughly inspected for conformance with the plans and this specification. Any indication of defects in materials or workmanship shall be further investigated and corrected. The earth resistance to ground of each ground rod shall not exceed 25 ohms. Each ground rod shall be tested using the fall-of-potential ground impedance test per American National Standards Institute / Institute of Electrical and Electronic Engineers (ANSI/IEEE) Standard 81. This test shall be performed prior to establishing connections to other ground electrodes.

115-3.13 Manhole elevation adjustments. The Contractor shall adjust the tops of existing manholes in areas designated in the Contract Documents to the new elevations shown. The Contractor shall be responsible for determining the exact height adjustment required to raise or lower the top of each manhole to the new elevations. The existing top elevation of each manhole to be adjusted shall be determined in the field and subtracted/added from the proposed top elevation.

The Contractor shall remove/extend the existing top section or ring and cover on the manhole structure or manhole access. The Contractor shall install precast concrete sections or grade rings of the required dimensions to adjust the manhole top to the new proposed elevation or shall cut the existing manhole walls to shorten the existing structure, as required by final grades. The Contractor shall reinstall the manhole top section or ring and cover on top and check the new top elevation.

The Contractor shall construct a concrete slab around the top of adjusted structures located in graded areas that are not to be paved. The concrete slab shall conform to the dimensions shown on the plans.

115-3.14 Duct extension to existing ducts. Where existing concrete encased ducts are to be extended, the duct extension shall be concrete encased plastic conduit. The fittings to connect the ducts together shall be standard manufactured connectors designed and approved for the purpose. The duct extensions shall be installed according to the concrete encased duct detail and as shown on the plans.

METHOD OF MEASUREMENT

115-4.1 Electrical Manholes and Junction Structures shall be measured based on the percentage of work completed of the contract lump sum as determined by the RPR.

BASIS OF PAYMENT

115-5.1 Electrical Manholes and Junction Structures will be paid for as a percentage of the contract lump sum based on the work completed as determined by the RPR.

Payment will be made under:

Item L-115	Electrical Manholes and Junction Structures

REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

American National Standards Institute / Insulated Cable Engineers Association (ANSI/ICEA)

ANSI/IEEE STD 81	IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

Advisory Circular (AC)

AC 150/5345-7	Specification for L-824 Underground Electrical Cable for Airport Lighting Circuits
AC 150/5345-26	Specification for L-823 Plug and Receptacle, Cable Connectors
AC 150/5345-42	Specification for Airport Light Bases, Transformer Housings, Junction Boxes, and Accessories
AC 150/5340-30	Design and Installation Details for Airport Visual Aids
AC 150/5345-53	Airport Lighting Equipment Certification Program

Commercial Item Description (CID)

A-A 59544	Cable and Wire, Electrical (Power, Fixed Installation)

ASTM International (ASTM)

ASTM A27	Standard Specification for Steel Castings, Carbon, for General Application
ASTM A47	Standard Specification for Ferritic Malleable Iron Castings
ASTM A48	Standard Specification for Gray Iron Castings
ASTM A123	Standard Specification for Zinc (Hot Dip Galvanized) Coatings on Iron and Steel Products
ASTM A283	Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates
ASTM A536	Standard Specification for Ductile Iron Castings
ASTM A615	Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement
ASTM A897	Standard Specification for Austempered Ductile Iron Castings
ASTM C144	Standard Specification for Aggregate for Masonry Mortar
ASTM C150	Standard Specification for Portland Cement
ASTM C206	Standard Specification for Finishing Hydrated Lime

FAA Engineering Brief (EB)

EB #83	In Pavement Light Fixture Bolts

Mil Spec

MIL-P-21035	Paint High Zinc Dust Content, Galvanizing Repair

National Fire Protection Association (NFPA)

NFPA-70 National Electrical Code (NEC)

END OF ITEM L-115

ADDITIONAL SPECIFICATIONS

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SECTION 02 41 19 - SELECTIVE DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Demolition and removal of selected portions of building or structure.
2. Demolition and removal of selected site elements including cutting away, breaking out, and removing portions of existing paving where indicated.
3. Removal of designated equipment and fixtures.
4. Identification of utilities.
5. Legal offsite disposal of demolition materials.
6. Salvage of existing items to be reused or recycled.

1.2 DEFINITIONS

A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.

B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to Owner ready for reuse or store as agreed.

C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse, and reinstall where indicated.

D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled.

E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.3 MATERIALS OWNERSHIP

A. Unless otherwise indicated, demolition waste becomes property of Contractor.

1.4 ACTION SUBMITTALS

A. Schedule: Submit sequence of demolition operations to Owner for review prior to start of work to prevent interruption of onsite operations.

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity.
2. Coordinate shutoff, capping, and continuation of utility services as required and interruption of utility services.
3. Details for dust and noise control protection.
4. Coordinate with Owner's continuing occupation of portions of existing building.

5. Use of elevator and stairs.
6. Location of salvageable items.
7. Detailed sequence of selective demolition and removal work to ensure uninterrupted progress of Owner's on site operations.
8. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed Work.
9. Locations of temporary partitions and means of egress.

B. Shop Drawings: Indicate location and construction of temporary work.

C. Concrete Cutting: Submit 3 copies of proposed cutting procedures and operations for each type of concrete demolition for review and approval prior to starting the work. Outline types of equipment proposed, protections to be installed, and cutting schedule.

D. Roof Removal: Submit procedures indicating compliance with manufacturer's warranty (if required) and schedule for roof removal.

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: Submit copies of qualification data for refrigerant recovery technician.

B. Engineering Survey: Submit engineering survey of condition of building.

C. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and, for noise control where necessary. Indicate proposed locations and construction of barriers.

D. Schedule of Selective Demolition Activities:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure Owner's and any occupant’s on site operations are uninterrupted.
2. Interruption of utility services. Indicate how long utility services will be interrupted and confirm coordinated interruption schedule and duration with Owner.
3. Coordination for shutoff, capping, and continuation of utility services.
4. Use of elevator and stairs.
5. Dust and noise control protection
6. Location of salvageable items.
7. Location of construction for temporary work
8. Coordination of Owner's continuing occupancy of portions of existing building and of Owner's partial occupancy of completed work.

E. Predemolition Photographs or Video: Show existing conditions of adjoining construction, including finish surfaces, that might be misconstrued as damage caused by demolition operations. Comply with Section 01 32 33. Submit prior to commencement of the work.

F. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating that all refrigerant that was present was

recovered and that recovery was performed according to EPA regulations. Include name and address of technician and date refrigerant was recovered.

G. Permits: Submit permits, notices and certificates authorizing demolition work, necessary for utility work, and for transportation and disposal of debris.

H. Project Record Documents: Accurately record actual locations of any capped utilities, subsurface obstructions, and other below ground or concealed conditions.

I. Warranties: Documentation indicating that existing warranties remain in effect after completion of selective demolition.

J. Inventory: Submit a list of items for removal and salvage prior to start of demolition.

1.6 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with applicable federal, state, and local codes for demolition work, dust and noise control, safety of structure, and debris removal.
2. Obtain required permits from authorities having jurisdiction.

B. Refrigerant Recovery Technician Qualifications: Certified by an EPA approved certification program.

C. Predemolition Conference: Conduct conference at site.

1. Inspect and discuss condition of construction to be selectively demolished.
2. Review structural load limitations of existing structure.
3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment, and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection.

1.7 FIELD CONDITIONS

A. Occupancy: Owner will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted. Provide minimum of 72 hours' notice to Owner of demolition activities that will affect Owner's operations including but not limited to:

1. Interruption of power.
2. Interruption of utility services.
3. Excessive noise.
4. Coordinate all such activities with the Owner in advance of Work.

B. Condition of Structure: Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.

1. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

C. Notify Architect of discrepancies between existing conditions and Drawings before proceeding with selective demolition.

D. Hazardous Materials: It is not anticipated that hazardous materials will be encountered in the work.

1. If suspected hazardous materials are encountered, do not disturb; immediately notify Architect and Owner. Hazardous materials will be removed by Owner under a separate contract. Work shall continue in other areas of project unaffected by hazardous materials.

E. Storage or sale of removed items or materials on site is not permitted.

F. Traffic: Conduct operations and debris removal to ensure minimum interference with roads, streets, drives, fire lanes, walks, accessible paths, and adjacent occupied or used facilities and in compliance with the Local Authority Having Jurisdiction.

1. Do not close, block, or obstruct streets, drives, walks, or occupied or used facilities without written permission from authorities having jurisdiction. Provide alternate routes around obstructed traffic ways.
2. Provide traffic path cleaning on a daily basis and as required by the authorities having jurisdiction.

G. Flame Cutting: Do not use cutting torches for removal until flammable materials are removed. At concealed spaces, verify conditions prior to flame cutting operations. Maintain portable fire suppression devices during flame cutting operations.

H. Environmental Controls: Use water sprinkling, temporary enclosures, or other acceptable methods to limit dust and dirt migration. Comply with governing regulations pertaining to environmental protection. Do not use water when it may create hazardous or objectionable conditions.

I. Utility Services: Maintain existing utilities and protect against damage during demolition operations.

1. Do not interrupt utilities serving occupied or used facilities, except when authorized in writing by authorities having jurisdiction. Provide temporary services during interruptions to existing utilities, acceptable to Owner and governing authorities.
2. Maintain fire protection facilities in service during selective demolition operations.

J. Protections: Provide temporary barriers to protect Owner's personnel and public from injury from work.

1. Take protective measures to provide free and safe passage to occupied portions of building.
2. Provide protection to ensure safe passage of the Owner's personnel and the public around demolition areas and to and from occupied portions of adjacent areas, buildings, and structures.
3. Provide shoring, bracing, or support to prevent movement, settlement, or collapse of structure or element to be demolished and adjacent facilities or work to remain.
4. Protect existing work which becomes exposed during demolition operations.

    a. Protect existing improvements, appurtenances, and conditions to remain.
    b. Protect adjacent floors with coverings.
    c. Protect walls, openings, roofs, and adjacent exterior construction to remain and exposed to building demolition operations.

5. Construct temporary insulated dustproof partitions to separate areas from noisy or extensive dirt or dust operations are performed. Equip partitions with dustproof doors and security locks.
6. Provide temporary weather protection when exposing exterior conditions to prevent water leakage or damage to structure or interior areas of existing building.

K. Damages: Promptly repair damages caused to adjacent facilities by demolition work.

L. Fire Arms and Explosives: Fire arms and explosives are not permitted at the site.

1.8 COORDINATION

A. Arrange selective demolition schedule so as not to interfere with Owner's operations.

B. Coordinate selective demolition work with cutting and patching requirements.

1.9 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify warrantor before proceeding. Confirm all existing warranties with Owner prior to Bid or Pricing.

B. Notify warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Demolition Standards: Comply with ASSE A10.6 and NFPA 241.

2.2 MATERIALS

A. Repair Materials: Use repair materials identical to existing materials.

1. If identical materials are unavailable or cannot be used for exposed surfaces, use materials visually matching existing adjacent surfaces.
2. Use materials whose installed performance equals or surpasses that of existing materials.

B. Comply with material and installation requirements specified in individual Specification Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify utilities have been disconnected and capped before starting selective demolition operations.

B. Review Project Record Documents of existing construction or other existing condition and hazardous material information provided by Owner. Owner does not guarantee that existing conditions are same as those indicated in Project Record Documents.

C. Perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

1. Perform surveys as the Work progresses to detect hazards resulting from selective demolition activities.

D. Steel Tendons: Locate tensioned steel tendons and include recommendations for detensioning prior to cutting.

E. Verify hazardous materials have been remediated before proceeding with building demolition operations.

F. Survey of Existing Conditions: Record existing conditions by use of measured drawings or preconstruction photographs and video.

1. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.
2. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final work, make permanent record of measurements, materials, and construction details required to make exact reproduction.

G. Where cutting of existing masonry or concrete materials is necessary, conduct nondestructive examination to identify and locate any concealed items as specified in Section 01 45 36 Concrete Imaging.

3.2 PREPARATION

A. Refrigerant: Before starting demolition, remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction.

B. Pest Control: Employ certified, licensed exterminator to treat building and to control rodents and vermin before and during selective demolition operations.

C. Site Access and Temporary Controls: Conduct selective demolition and debris removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities. Comply with requirements for access and protection.

3.3 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.

B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.

1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
2. Arrange to shut off utilities with utility companies.
3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
4. Disconnect, demolish, and remove fire-suppression systems, plumbing, and HVAC systems, equipment, and components indicated on Drawings to be removed.

    a. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
    b. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material and leave in place.
    c. Equipment to Be Removed: Disconnect and cap services and remove equipment.
    d. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
    e. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner.
    f. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.

g. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material and leave in place.

3.4 PROTECTIONS

A. Temporary Protection: Provide temporary barricades and protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.

1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied portions of building.

    a. Erect temporary pathways and means of egress necessary for ongoing operations compliant with Code and accessibility regulations.
    b. Provide temporary barricades and protection required to prevent injury and damage to adjacent buildings and facilities to remain.

2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
3. Protect walls, ceilings, floors, and other existing finish work that are to remain or that are exposed during selective demolition operations.

    a. Protect existing work which becomes exposed during demolition operations.
    b. Protect adjacent entrances from damage due to demolition activities.
    c. Protect existing improvements, appurtenances, and conditions to remain.
    d. Protect floors with covering.
    e. Protect walls, openings, roofs, and adjacent exterior construction to remain and exposed to building demolition operations.

4. Cover and protect furniture, furnishings, and equipment that have not been removed.
5. Comply with requirements for temporary enclosures, dust control, heating, and cooling.

    a. Construct temporary insulated dustproof partitions to separate areas from noisy or extensive dirt or dust operations are performed. Equip partitions with dustproof doors and security locks.
    b. Construct dustproof partitions of not less than nominal 4 inch (100mm) studs, 5/8 inch (16mm) gypsum wallboard with joints taped on occupied side, and 1/2 inch (13mm) fire retardant plywood on the demolition side.
    c. Insulate partition to provide noise protection to occupied areas.
    d. Seal joints and perimeter. Equip partitions with dustproof doors and security locks.
    e. Protect air handling equipment.
    f. Weatherstrip openings.

6. Damage: Promptly repair damages to adjacent components cause by demolition activities.

B. Temporary Partitions and Enclosures: Erect and maintain dustproof partitions and temporary enclosures to limit dust and dirt migration and to separate areas from fumes and noise.

1. Construct dustproof partitions of not less than nominal 4 inch (100mm) studs, 5/8 inch (16mm) gypsum wallboard with joints taped on occupied side, and 1/2 inch (13mm) fire retardant plywood on the demolition side.
2. Insulate partition to provide noise protection to occupied areas.
3. Seal joints and perimeter to prevent dust from mitigating to occupied areas. Equip partitions with dustproof doors and security locks.
4. Protect air handling equipment.

C. Furnishings and Equipment: Cover and protect furniture, equipment, and fixtures from spoilage or damage as necessary.

D. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.

1. Strengthen or add new supports when required during progress of selective demolition.

E. Remove temporary barricades and protections where hazards no longer exist.

3.5 SELECTIVE DEMOLITION

A. Conduct demolition to minimize interference with all existing and adjacent building areas and to cause as little inconvenience to Owner and employees of occupied buildings as possible. Do not interfere with use of adjacent public streets.

1. Cease operations immediately if structure appears to be in danger and notify Architect. Do not resume operations until directed.
2. Maintain protected egress and access to work.
3. Do not burn or bury materials on site. No explosive or blasting will be allowed for demolition.

B. Demolish and remove existing construction to the extent required by new construction and as indicated. Use methods required to complete the work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.

4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame cutting operations. Maintain portable fire suppression devices during flame cutting operations.
5. Maintain fire watch during and for at least 24 hours after flame cutting operations.
6. Maintain ventilation when using cutting torches.
7. Remove decayed, vermin infested, and dangerous or unsuitable materials and promptly and legally dispose off site.
8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
10. Dispose of demolished items and materials promptly.

C. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

D. Removed and Salvaged Items: Remove items and equipment indicated for salvage. Photograph items with existing damage prior to removal. Submit list of damage items with supporting photographs and videos. Clean and pack or crate items after cleaning. Identify contents of containers. Store items in secure area until delivery to Owner.

1. Transport items to Owner's storage area designated by Owner. Protect items from damage during transport and storage.

E. Removed and Reinstalled Items: Clean and repair items to functional condition adequate for intended reuse.

1. Pack or crate items after cleaning and repairing. Identify contents of containers.
2. Protect items from damage during transport, storage and reinstallation for the duration of construction.
3. Store items in secure storage, off ground, and covered. Protect until items are reinstalled.
4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.

F. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition cleaned and reinstalled in original locations after selective demolition operations are complete.

G. Patching and Repair: Repair damage to adjacent construction caused by selective demolition operations promptly.

3.6 SELECTIVE DEMOLITION PROCEDURES FOR SPECIFIC MATERIALS

A. Concrete: Demolish in sections. Identify all embedded items as indicated in Section 01 45 36 Concrete Imaging. Mark all item locations and coordinate intended protection. Cut

concrete full depth at junctures with construction to remain and at regular intervals using power driven saw, and then remove concrete between saw cuts.

B. Masonry: Identify all embedded items as indicated in Section 01 45 36 Concrete Imaging. Mark all item locations and coordinate intended protection. Demolish in small sections. Cut masonry at junctures with construction to remain, using power driven saw, and then remove masonry between saw cuts.

C. Concrete Slabs on Grade: Saw cut perimeter of area to be demolished, and then break up and remove. Provide full depth cuts to achieve clean viable edges for tie in of new materials and terminal edge conditions.

D. Interior Slab on Grade: Identify all embedded items as indicated in Section 01 45 36 Concrete Imaging. Mark all item locations and coordinate intended protection. Use best practice removal methods to prevent cracking or structurally disturbing adjacent slabs or partitions. Use power saw where possible. Provide full depth cuts to achieve clean viable edges for tie in of new materials and terminal edge conditions.

E. Below Grade Voids: Completely fill below grade areas and voids resulting from demolition work. Provide fill consisting of approved earth, gravel, or sand, free of trash and debris, stones over 6 inches (150 mm) in diameter, roots, or organic matter.

F. Resilient Floor Coverings: Remove floor coverings and adhesive according to recommendations in RFCI Recommended Work Practices for the Removal of Resilient Floor Coverings.

G. Partitions: Completely remove indicated interior partitions and interior finishes indicated. Leave adjacent work scheduled to remain sound and ready for patching or for new finishes.

H. Doors and Frames: Remove doors, frames, and hardware where indicated. Remove anchors, shims, trim, and attachments. Leave opening ready to receive new work. Remove from site. For any items to be reinstalled clean, store, and protect for reinstallation or return hardware to Owner as directed.

I. Cut existing masonry walls for new openings where indicated. Leave openings ready to receive new work or patching.

J. Windows: Remove existing windows where indicated. Remove associated anchors, shims, blocking, operating devices, sealant, and trim. Cut back interior finishes required for plumb surface for patching. Leave openings ready for installation of new materials and finishes or to be infilled.

K. Mechanical, Electrical, and Structural Elements: If unanticipated mechanical, electrical, or structural elements conflicting with intended function or design are encountered, investigate and measure both nature and extent of the conflict.

1. Submit written report to Architect in accurate detail. Pending receipt of directive, rearrange selective demolition schedule as necessary to continue overall job progress without undue delay.

2. HVAC Equipment: Remove air conditioning equipment without releasing refrigerants.

3.7 REMOVAL OF STRUCTURAL ELEMENTS

A. Foundation: Demolish foundation walls to a minimum depth of 12 inches (300mm) below existing ground surface. Demolish and remove below grade wood or metal construction. Break up below grade concrete slabs.

1. Interior Slabs on Grade: Employ removal methods to prevent cracking or structurally disturbing adjacent slabs or partitions. Use power saw where possible.
2. Completely fill below grade areas and voids resulting from demolition work. Provide fill consisting of approved earth, gravel, or sand, free of trash and debris, stones over 6 (150mm) inches in diameter, roots, or other organic matter.

B. Pneumatic Operated Hammers: When possible, reduce use of pneumatic operated hammers. When necessary to use pneumatic tools, locate compressors as remote form occupied areas as possible.

1. To break large pieces of concrete, isolate concrete from floor slabs and building structure to prevent structure borne vibration.

C. Saw Cutting: Locate compressors as remote as possible from occupied areas of facility.

1. Use diamond tipped saw blades and related equipment.
2. Saw cut portions of walls and slabs to be removed. Angle saw blade at floors and corners to cut as closely as possible to desired location. Provide full depth cuts to achieve clean viable edges for tie in of new materials and terminal edge conditions.
3. Control runoff water used with saw to prevent damage to existing materials.

3.8 ROOF REMOVAL

A. Roof Assembly: Remove existing roofing to the extent that can be covered in one day by new roofing. Maintain building interior in watertight and weathertight condition.

1. Remove existing roof membrane, flashings, copings, and roof accessories.
2. Remove existing roofing system down to substrate.

B. At new column extensions, cut through roofing as required for welding of new extension. Provide temporary watertight enclosure over stubs and temporarily flash to existing roof to make completely watertight.

C. At existing parapets, remove portions of roofing, flashing, stone, and masonry necessary to weld new steel and set form work. Provide temporary watertight enclosures over areas of open roof and temporarily flash to make watertight.

D. As column forms are placed, temporarily flash columns to existing roofing and cover with watertight tarpaulins before and after pouring. After column forms have been removed,

temporarily flash new concrete structure into existing roofing immediately to maintain watertight roof.

E. When removing roofing to place supports for shoring of form work to transfer loads to existing columns or approved structure or to support scaffolding, work platforms, or similar loads, temporarily flash supports to make roof watertight.

F. Remove excess residue. Thoroughly clean and remove asphalt, dust, loose materials and leave ready for new work.

3.9 PATCHING AND REPAIRS

A. Promptly repair damage to adjacent construction caused by selective demolition operations. Refinish construction or item to a condition comparable or better than before selective demolition operations or replace with new.

B. Patching: Comply with Section 01 73 19.

C. Repairs: When necessary to repair to existing surfaces, patch to produce surfaces suitable for new materials.

1. Fill holes and depressions in existing masonry walls to remain with masonry patching material applied according to manufacturer's written recommendations.

D. Finishes: Restore exposed finishes of patched areas and extend restoration into adjoining construction in a manner that eliminates evidence of patching and refinishing.

E. Floors and Partitions: Where walls or partitions are demolished, extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish color, texture, and appearance. Remove existing floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

1. Patch with durable seams that are as invisible as possible. Provide materials and comply with installation requirements specified in other Sections of these Specifications.
2. Where patching occurs in a painted surface, apply primer and intermediate paint coats over patch and apply final paint coat over entire unbroken surface containing patch. Provide additional coats until patch blends with adjacent surfaces.
3. Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.

F. Ceilings: Patch, repair, or rehang existing ceilings as necessary to provide an even plane surface of uniform appearance.

3.10 REPAIRS OF CONCRETE WALL PANELS

A. Repair concrete wall panel units affected by the Work as directed by Architect. Architect reserves the right to reject repaired units that do not comply with requirements.

B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet (6 m).

C. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A780/A780M.

D. Wire brush, clean, and paint damaged prime painted components with same type of shop primer.

E. Remove and replace damaged architectural precast concrete units when repairs do not comply with requirements.

3.11 DISPOSAL OF DEMOLISHED MATERIALS

A. Legally remove demolition waste materials from site to comply with the following:

1. For waste materials to be disposed, dispose in an EPA approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
2. For waste materials to be recycled, process waste accordingly and transport to recycling entity or facility. Storage of materials onsite shall not be permitted beyond 30 days or other reasonable duration approved by the Owner.
3.
4. Do not allow demolished materials to accumulate on-site.
5. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
6. Remove debris from elevated portions of building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.

B. Burning: Do not burn demolished materials.

3.12 CLEANING

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

B. Remove partitions and temporary work. Restore surfaces to match adjacent surfaces.

END OF SECTION

SECTION 04 22 19 - INSULATED CONCRETE UNIT MASONRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: The section includes the installation of the following:

1. Insulated concrete masonry units (ICMU).

1.2 REFERENCES

A. Definitions:

1. CMU: Concrete masonry unit(s).
2. ICMU(s): Insulated concrete masonry unit(s) without pigments added.
3. Decorative ICMU(s): Insulated concrete masonry unit(s) with one or more components are of decorative masonry units with integral color, textured finish (ground, polished, filled and polished, shot blasted, smooth face).
4. Reinforced Masonry: As defined by NCMA TEK 1-4 “Glossary of Concrete Masonry Terms:”

    a. “Masonry containing reinforcement in the mortar joints or grouted cores used to resist stresses. Unit masonry in which reinforcement is embedded in such a manner that the component materials act together to resist applied forces.”

5. Non-Structural Thin Veneer: Thin, decorative concrete units of various shapes, colors, and finishes.
6. Structural CMU: Concrete masonry units (CMU) with open cells complying with ASTM C90 “Standard Specification for Loadbearing Concrete Masonry Units” used in either load bearing or non-load bearing conditions.
7. Dimensions: All unit sizes are shown as Nominal Dimensions.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meetings: Conduct Preinstallation Meeting at job site.

1.4 ACTION SUBMITTALS

A. Product Data: Provide Manufacturer’s Product Data for each type of product specified.

1. ICMU, including structural CMU and non-structural thin veneer components with insulation as a complete unit, including integral water repellant.
2. Decorative ICMU, including structural CMU and non-structural thin veneer components with insulation as a complete unit, including integral water repellant.
3. Mortar, including integral water repellant.
4. Grout.
5. Prefabricated Flashing.
6. Flashing.
7. Weeps.

B. Shop Drawings: Provide Shop Drawings indicating installation details, including the following:

1. Special ICMU Shapes: Provide drawings indicating sizes, configuration, and locations of special shapes.
2. Reinforcing: Provide drawings indicating reinforcing that complies with ACI 315 “Details and Detailing of Concrete Reinforcement” and includes the following:
    a. Provide elevations indicating steel reinforcing bar placement.
    b. Provide details indicating steel reinforcing bar sizes, placement, bends, and laps dimensions.

C. Samples: Submit samples for each type of product specified.

1. ICMU, including structural CMU and non-structural thin veneer components with insulation as a complete unit.
2. Decorative ICMU, including structural CMU and non-structural thin veneer components with insulation as a complete unit.

D. Samples, Selection Set: Submit complete series of manufacturer’s standard colors and finishes, in manufacturer's standard size, for the following:

1. Decorative ICMU, including structural CMU and non-structural thin veneer components with insulation as a complete unit.
2. Non-Structural Thin Veneer
3. Colored Mortar with integral water repellant.

E. Samples, Confirmation Set: For each product color and finish selection to be made by the Architect from the Selection Set of Samples, provide manufacturer's standard size, for the following:

1. Decorative ICMU, including structural CMU and non-structural thin veneer components with insulation as a complete unit.
2. Non-Structural Thin Veneer.
3. Colored Mortar with integral water repellant.

1.5 INFORMATIONAL SUBMITTALS

A. Certificates: For each of the following materials, submit documentation, on product manufacturer’s letterhead, stating that materials comply with requirements of the Contract Documents.

1. CMUs, General: Submit certifications stating material properties of materials, including test reports verifying properties stated.
2. Structural CMUs: Submit data and calculations demonstrating average net area compressive strength of CMUs.
3. ICMU, including structural CMU and non-structural thin veneer components with insulation as a complete unit.
4. Decorative ICMU, including structural CMU and non-structural thin veneer components with insulation as a complete unit.
5. Non-Structural Thin Veneer.
6. Insulation.
7. Mortar with integral water repellant.
8. Grout.
9. Steel reinforcing.

B. Delegated Design Submittals: Provide engineering design calculations.

C. Test and Evaluation Reports:

1. Compressive Strength Report: Submit report of the following properties for each combination of masonry unit type and mortar type to be incorporated in the Work calculated according to the standards of “Specifications for Masonry Structures” (ACI 530.1/ ASCE 6/TMS 602):

    a. Average net area compressive strength of masonry units.
    b. Average net area compressive strength of mortar types.
    c. Resulting net area compressive strength of masonry construction.

1.6 QUALITY ASSURANCE

A. Licensed Professionals:

1. Owner to retain an experienced, professional, structural engineer who is legally qualified to practice in the jurisdiction where the project is located to calculate design of masonry reinforcing requirements and to prepare construction documents for installation of reinforced masonry.

B. Mockups: Construct mockup of typical exterior wall, as indicated on the Drawings, to exhibit aesthetic effects, to confirm product selections and placement, and to establish construction quality standards.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Delivery and Acceptance Requirements: Deliver CMUs and other cementitious materials neatly stacked on pallets.

B. Storage and Handling Requirements: Store CMUs and other cementitious materials on elevated platforms in a dry, sheltered location.

1. If sheltered location is not available, completely cover tops and side of stored CMUs and other cementitious materials with a waterproof tarp that is securely restrained from exposing covered materials to precipitation.

1.8 FIELD CONDITIONS

A. Protection During Construction:

1. Comply with protection recommendations of NCMA TEK 8-4A “Cleaning Concrete Masonry.”
2. At the end of each day’s work, cover top of masonry construction with a waterproof tarp that is securely restrained from exposing covered work to precipitation.

    a. Extend protective covering a minimum of 24 inches down each side of masonry construction.

3. Spread protective covering over ground and wall surfaces to protect in place masonry work from mud splatter.
4. Protect work adjacent to and below masonry work from grout and mortar droppings, including the following surfaces:

    a. Sills
    b. Ledges
    c. Projections
    d. Window and door frames.

5. Immediately remove grout, mortar, and soil that comes in contact with exposed masonry work.

B. Weather Conditions:

1. Ambient Conditions: Comply with working recommendations of the International Masonry Industry All Weather Council (IMIAWC) regarding weather conditions.
2. Cold Weather and Hot Weather Construction: Comply with recommendations of ACI 530 “Building Code Requirements and Specification for Masonry Structures” and IMIAWC “Recommended Practices and Guide Specifications for Cold Weather and Hot Weather Masonry Construction.”

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design Manufacturer: Subject to compliance with requirements, provide Insultech products by Echelon, a member of the Oldcastle Company.

2.2 PERFORMANCE CRITERIA

A. Structural Performance Requirements: Provide reinforced masonry construction designed to comply with the following requirements:

1. Design Standards: Comply with the design recommendations of the following:
   a. ACI 530/530.1-13, “Building Code Requirements and Specification for Masonry Structures and Companion Commentaries.”
   b. NCMA TEK 12-4D “Steel Reinforcement for Concrete Masonry.”
   c. NCMA TEK 14-19A “Allowable Stress Design Tables for Reinforced Concrete Masonry Walls.”
   d. NCMA TEK 16-3B “Reinforced Composite Concrete Masonry Walls.”
2. Dead Loads: As indicated on the Drawings.
3. Live Loads: As indicated on the Drawings.
4. Wind Loads: As indicated on the Drawings.
5. Seismic Loads: As indicated on the Drawings.

B. Thermal Resistive Performance Requirements:

1. R-Value: 16.0 at 75 degrees F.

C. Fire Resistive Performance Requirements: As indicated on Drawings.

1. Determine fire resistant rating according to testing complying with ASTM E 119 testing methods or by other means, as acceptable to authorities having jurisdiction.
2. For ICMU within fire rated assemblies, provide units which have been listed and labeled by a qualified testing agency which is acceptable to the local authority having jurisdiction.

D. Water Penetration Resistance: CMU shows no visible water or leaks on back of test specimen after 24 hours when tested according to ASTM E514 / E514M “Standard Test Method for Water Penetration and Leakage Through Masonry.”

2.3 CONCRETE MASONRY UNITS, GENERAL

A. Masonry Standard: Provide concrete masonry complying with ASTM C90 “Standard Specification for Loadbearing Concrete Masonry Units.”

1. Density: Provide ICMU of the following density:

a. Lightweight CMU: Less than 105 lb/cu. ft..
b. Medium weight CMU: At least 105 lb/cu. ft. but less than 125 lb/cu. ft..
c. Normal weight CMU: 125 lb/cu. ft. or more.

B. Pigments: ASTM C979 “Standard Specification for Pigments for Integrally Colored Concrete,” inorganic iron oxide pigments.

C. Integral Water Repellant: Liquid polymeric, admixture that does not reduce flexural bond strength.

1. Integral Water Repellant Product: Subject to compliance with requirements, provide product recommended the following or by manufacturer’s recommendation:

a. RainBloc Water Repellent Masonry Unit admixture, manufactured by ACM Chemistries, Inc.

D. Integral Water Repellent. Certified by ICMU manufacturer to have been tested and

2.4 INSULATED CONCRETE MASONRY UNITS

A. ICMU: Preassembled, structural ICMU, with no added pigment and no applied texture or finish, consisting of a structural CMU and a thin, non-structural CMU veneer separated by a graphite polystyrene (GPS) molded insulation thermal break and held together as a single unit.

1. Components:

a. Structural CMU: CMU with unfinished exposed interior face and dovetailed slots on the opposite face.
b. Insulation: Nominal 3 inches thick Molded GPS insulation.
c. Non-Structural Thin Veneer: Nominal 1-5/8 inches thick CMU with unfinished exposed exterior face and dovetailed slots on the opposite face.

B. Decorative ICMU, Type <Insert Designation>: Pre-assembled, structural ICMU consisting of a structural CMU and a decorative non-structural thin veneer separated by a graphite polystyrene (GPS) molded insulation thermal break and held together as a single unit.

1. Non-Structural Thin Veneer CMU:

a. Thin Veneer, with added pigment and with no applied texture.
b. Color and Finish: As selected by the Architect from masonry manufacturer’s full range.

2. Insulation: Nominal 3 inches thick Molded GPS insulation.
3. Structural CMU Backup:

a. Structural CMU, with added pigment and with no applied texture.
b. Color and Finish: As selected by the Architect from masonry manufacturer’s full range.

4. Unit Sizes: See Drawings.

2.5 INSULATION

A. Product: Subject to compliance with requirements, provide Neopor by BASF.

B. Graphite polystyrene (GPS): Closed cell, GPS insulation complying with ASTM C578 “Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation” Type II insulation, molded to interlock with the structural CMU and non-structural thin veneer components of ICMU and with male and female connections to interlock with adjacent ICMU units.

1. Density: 1.35 lb/cu. ft..
2. Compressive Strength (Resistance): 15.0 psi.

2.6 SPECIAL SHAPES

A. Provide special shapes as required to complete the masonry work as indicated on the Drawings without requiring field cutting , including the following:

1. Left and right hand corners units.
2. Left and right hand corner continuation units.
3. Open end stretcher units.
4. Closed end stretcher units.
5. Double sash units.
6. Left and right hand half sash units.
7. Veneer stretcher units.
8. Veneer left and right hand corners units.
9. Left and right hand 4-inch return jamb block units.

2.7 CONCRETE MASONRY LINTELS

A. Bond Beam Units: Provide closed bottom CMU bond beams matching properties and dimension of ICMU structural CMU component, including color and finish of exposed ICMU faces.

1. Provide Veneer stretcher units where required to match ICMU non-structural thin veneer.

2.8 CONCRETE LINTELS

A. Comply with requirements of Section 033000 "Cast-in-Place Concrete".

B. Precast Concrete Lintel: Provide steel reinforced, precast concrete lintels complying with ASTM C1623 “Standard Specification for Manufactured Concrete Masonry Lintels” with color, texture, and density matching ICMU.

2.9 STEEL LINTELS

A. Comply with requirements of Section 05 50 00 “Metal Fabrications”.

B. Provide galvanized and factory primed steel angles and shapes as indicated on the Drawings.

1. Size steel lintels to support dead loads over openings but not less than sizes indicated on the Drawings.

2. Provide minimum of 8 inches of bearing on each side of opening but not less than required based on masonry's bearing capacity.

2.10 MORTAR AND GROUT MATERIALS

A. General: Comply with recommendations of the following:

1. NCMA TEK 9-1A Mortars for Concrete Masonry.
2. NCMA TEK 9-4A Grout for Concrete Masonry.

B. Portland Cement: Comply with ASTM C150 "Standard Specification for Portland Cement" using one of the following portland cement Types:

1. Type I, normal.
2. Type II, moderate sulfate resistance.
3. Type III, high early strength, maybe used for cold weather conditions.

C. Hydrated Lime: Comply with ASTM C207 "Standard Specification for Hydrated Lime for Masonry Purposes," Type S (special).

D. Aggregates:

1. Aggregates for Mortar: Comply with ASTM C144 "Standard Specification for Aggregate for Masonry Mortar."
2. Aggregates for Grout: Comply with ASTM C404 "Standard Specification for Aggregates for Masonry Grout."

E. Packaged Cement Mix: Packaged, factory blended mix of portland cement and hydrated lime with no other components included.

F. Mortar Cement: Comply with ASTM C1329 "Standard Specification for Mortar Cement."

G. Pigments: Comply with ASTM C979 "Standard Specification for Pigments for Integrally Colored Concrete."

1. Comply with quantity limitation specified ASTM C1384 "Standard Specification for Admixtures for Masonry Mortars" when adding to mortar.

H. Admixtures: Comply with quantity limitation specified ASTM C1384 "Standard Specification for Admixtures for Masonry Mortars" when adding to mortar.

1. Cold Weather: Comply with ASTM C494 "Standard Specification for Chemical Admixtures for Concrete."
2. Integral Water Repellant: Liquid polymeric, admixture that does not reduce flexural bond strength.
    a. Integral Water Repellant Product: Subject to compliance with requirements, provide one of the following products:
        1) RainBloc® Water Repellent Masonry Unit admixture, manufactured by ACM Chemistries, Inc.

I. Water: Clean and drinkable.

2.11 REINFORCEMENT

A. Reinforcing Bars: Uncoated, deformed, steel reinforcing bars.

1. Provide bars complying with either of the following standards:

a. ASTM A615 “Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.”
b. ASTM A996 “Standard Specification for Rail-Steel and Axle-Steel Deformed Bars for Concrete Reinforcement.”

2. 60,000 psi.
3. Grade: 60,
4. Sizes: As indicated on structural Drawings .

B. Reinforcing Bar Positioners: Prefabricated wire elements configured to span masonry unit cells and hold reinforcing bars in position when cells are filled with grout. Provide reinforcing bar positioners configured to accommodate the masonry and reinforcing requirements indicated on the Drawings.

1. Wire Material: Provide wire made of one of the following materials:

a. Cold-drawn steel wire conforming to ASTM A106 “Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.”
b. Stainless steel wire conforming to ASTM A580 “Standard Specification for Stainless Steel Wire,” - AISI Type 304.

2. Wire Diameter: 0.148 inch minimum.
3. Wire Finish: Galvanized according to one of the following methods:

a. Mill Galvanized: ASTM A641 “Standard Specification for Zinc–Coated (Galvanized) Carbon Steel Wire” 0.1 ounces per square foot minimum thickness.
b. Hot Dipped Galvanized after Fabrication: ASTM A153-B2 “Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware” 1.5 ounces per square foot minimum thickness.

C. Joint Reinforcement, Ladder or Truss Type: Prefabricated wire ladder type joint reinforcement consisting of longitudinal rods with cross rods equally spaced, at a maximum of 16 inches on center, to avoid obstructing masonry unit cells.

1. Ladder Width: [Depth of structural CMU backup component of ICMU] <insert dimension>.
2. Wire Material: Provide wire made of one of the following materials:

a. Cold-drawn steel wire conforming to ASTM A106 “Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.”
b. Stainless steel wire conforming to ASTM A580 “Standard Specification for Stainless Steel Wire,” - AISI Type 304.

3. Longitudinal Rod Diameter: 0.148 inch minimum.
4. Cross Rod Diameter: 0.187 inch minimum.
5. Wire Finish: Galvanized according to one of the following methods:

a. Mill Galvanized: ASTM A641 “Standard Specification for Zinc–Coated (Galvanized) Carbon Steel Wire” 0.1 ounces per square foot minimum thickness.
b. Hot Dipped Galvanized after Fabrication: ASTM A153-B2 “Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware” 1.5 ounces per square foot minimum thickness.

D. Joint Reinforcement, Single Wire (Pencil Wire) Type:

1. Wire Material: Provide wire made of one of the following materials:
    a. Cold-drawn steel wire conforming to ASTM A106 “Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.”
    b. Stainless steel wire conforming to ASTM A580 “Standard Specification for Stainless Steel Wire,” - AISI Type 304.
2. Wire Diameter: 0.148 inch minimum.
3. Wire Finish: Galvanized according to one of the following methods:
    a. Mill Galvanized: ASTM A641 “Standard Specification for Zinc–Coated (Galvanized) Carbon Steel Wire” 0.1 ounces per square foot minimum thickness.
    b. Hot Dipped Galvanized after Fabrication: ASTM A153-B2 “Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware” 1.5 ounces per square foot minimum thickness.

2.12 ACCESSORIES

A. Field Applied, Water Repellant: Clear, water-based, penetrating water repellent for concrete and masonry.

1. Product: Subject to compliance with requirements and approval of the ICMU manufacturer.
    a. .

B. Prefabricated Flashing and Weeps:

1. Product: Subject to compliance with requirements, provide “BlockFlash™” as manufactured by Mortar Net Solutions™.
2. Flashing Material: Provide prefabricated flashing pans made from recycled polypropylene, chemically stabilized to inhibit degradation by ultraviolet radiation.
3. Flashing Configuration: Embeddable flashing device for exterior CMU construction with built-in slope to direct moisture to integrated weeps and prefabricated flashing manufacturer’s attached drainage mats and 1 inch extended insect guards.

C. Flexible Flashing: Provide one of the following flashing materials:

1. Butyl Rubber Flashing: 0.030 inch thick membrane consisting of a flexible, rubberized asphalt adhesive bonded to a high-density, cross-laminated polyethylene film.
2. Copper Foil Flashing: [5-oz./sq. ft.] [7-oz./sq. ft.] copper foil [laminated between 2 layers of fiber glass cloth] [coated with flexible asphalt].
3. EPDM Flashing: EPDM membrane, complying with ASTM D4637 “Standard Specification for EPDM Sheet Used In Single-Ply Roof Membrane,”, 0.045 inch thick.
4. Rubberized Asphalt Flashing: 0.040 inch thick membrane consisting of a 0.032 inch thick self-adhered rubberized asphalt laminated to an 0.008 inch thick, high density, polyethylene film with release liner to prevent product from sticking to itself.
5. Thermoplastic Vinyl Flashing: 0.040 inch thick thermoplastic vinyl membrane with UV stabilizers, self-adhered rubberized asphalt, and release liner to prevent product from sticking to itself.

D. Weeps: Free-draining [UV stabilized, open weave, polyester mesh] [UV stabilized, corrugated plastic vent] inserts for open head joints of masonry walls.

1. Do not install cotton chord drainage.
2. Color: As indicated on the Drawings As selected by the Architect from the manufacturer's full range of standard colors

E. Joint Sealants: Non-staining silicone sealant as specified in Section 07 92 00 "Joint Sealants."

F. Sealant Backer Rods: As specified in Section 07 92 00 "Joint Sealants."

1. Width and Thickness: As indicated on Drawings.

G. Masonry Control Joint Gasket: Provide preformed gasket strips designed to fit standard sash block and to maintain lateral stability in masonry walls, made of one of the following materials:

1. Styrene-butadiene rubber compound, complying with ASTM D 2000 "Standard Classification System for Rubber Products in Automotive Applications", Designation M2AA-805.
2. PVC, complying with ASTM D 2287 "Standard Specification for Nonrigid Vinyl Chloride Polymer and Copolymer Molding and Extrusion Compounds", Type PVC-65406.

2.13 MASONRY CLEANER

A. Acidic Cleaner: Standard strength cleaner designed to remove mortar and grout stains, efflorescence, and other construction related stains without discoloring and without damaging masonry and mortar surfaces and as approved by ICMU manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine in place construction, with mason present, to evaluate and verify the following:

1. That substrates to receive masonry work are within specified dimensional tolerances.
2. That substrates to receive masonry work are clean and have no conditions that would weaken bonding of mortar.
3. That steel reinforcing is the specified size and in the required location.

B. Correct unacceptable conditions before beginning installation.

3.2 PREPARATION

A. Prepare masonry and set reinforcement prior to grouting according to the recommendations of NCMA TEK 3-2A, "Grouting Concrete Masonry Walls."

3.3 INSTALLATION OF ICMUS

A. General:

1. Comply with written recommendation of ICMU manufacturer.
2. Do not install wet ICMUs.

3. Brace walls under construction according to the recommendations of NCMA TEK 3-4B, “Bracing Masonry Walls During Construction.”

B. Layout: Comply with requirements of NCMA TEK 3-8A, “Concrete Masonry Construction.”

1. Set first course of ICMU using units with integral water repellant.

C. Bond Pattern: Lay ICMUs in [a running bond pattern] [a stacked bond pattern] [[a pattern] [the patterns] indicated on Drawings] <insert bond pattern>.

D. Tolerances: Comply with requirements of NCMA TEK 3-8A, “Concrete Masonry Construction.”

E. Setting in Mortar: Comply with recommendations of NCMA TEK 3-1C through TEK 3-14 as applicable to the type of masonry construction and project conditions.

1. ICMU manufacturer’s stainless-steel “Bridge tool” is mandatory to install mortar at a uniform 3/4 inch joint thickness with an inside mortar cant to prevent interior mortar roll in during mortar compression as part of the unit installation and to maintain the drainage channels.
2. Take measures to minimize mortar droppings.

F. Grouting of Cores: Place grout in cells of ICMUs according to the recommendation of NCMA TEK 3-2A “Grouting Concrete Masonry Walls.”

G. Control and Expansion Joints: Unless otherwise indicated on Drawings, locate and install control and expansion joints according to one of the following standards:

1. NCMA TEK 10-2C “Control Joints for Concrete Masonry Walls - Empirical Method.”
2. NCMA TEK 10-3 “Control Joints for Concrete Masonry Walls - Alternative Engineered Method.”

H. Application of Water Repellant: Apply water repellant over entire exterior ICMU surface according to water repellant manufacturer’s written recommendations.

3.4 INSTALLATION OF LINTELS

A. Concrete Masonry Lintels: Install CMU lintels where indicated on Drawings.

1. Provide a minimum of 8 inches of bearing on each side of masonry opening, unless otherwise indicated on Drawings.
2. Temporary Bracing: Provide temporary bracing until grout has cured sufficiently to support applied loads, but not less than 7 days.
3. Reinforcing: Install reinforcing as indicated on Drawings, but not less than recommended in NCMA TEK 17-1D “ASD of CM Lintels Based on 2012 IBC/2011MSJC.”

B. Steel Angle Lintels: Install steel angle lintels where indicated on Drawings.

1. Provide a minimum of 8 inches of bearing on each side of masonry opening, unless otherwise indicated on Drawings.
2. Coordinate with Section 05 50 00 “Metal Fabrications.”

3.5 INSTALLATION OF FLASHING

A. Prefabricated Flashing and Weeps: Install prefabricated flashing and weep units at base course, at bond beams, at lintels, and other horizontal locations where ICMU cores are grouted solid.

1. Install prefabricated flashing and weep units according to manufacturer's written instructions.
2. Coordinate installation of prefabricated flashing and weep units with installation of other flashing work.

B. Flexible Flashing: Locate and install flexible flashing according to the recommendations of the following standards:

1. NCMA TEK 19-4A "Flashing Strategies for Concrete Masonry Walls."
2. NCMA TEK 19-5A "Flashing Details for Concrete Masonry Walls."

C. Weeps: Install weeps at the head joints of the non-structural thin veneer of the ICMUs directly above flashing.

1. Space weeps no more than 16 inches o.c. horizontally.

3.6 REINFORCED [DECORATIVE] ICMUS

A. Install reinforcing in masonry construction according to the following standards:

1. NCMA TEK 12-1B "Anchors and Ties for Masonry."
2. NCMA TEK 12-2B "Joint Reinforcement for Concrete Masonry."
3. NCMA TEK 12-3C "Design of Anchor Bolts Embedded in Conc. Masonry."
4. NCMA TEK 12-4D "Steel Reinforcement for Concrete Masonry."
5. NCMA TEK 12-5 "Fasteners for Concrete Masonry."
6. NCMA TEK 12-6 "Splices, Development & Standard Hooks for CM."
7. NCMA TEK 12-6A "Splices, Development and Standard Hooks for CM Based on the 2009 & 2012 IBC."

B. Ladder Type Joint Reinforcement: Set within the horizontal joints of the structural CMU components of the ICMU at a minimum of 16 inches on center vertical, unless otherwise indicated.

C. Single Wire (Pencil Wire) Type Joint Reinforcement: Set within the horizontal joints of the non-structural thin veneer components of the ICMU at a minimum of 16 inches on center vertical, unless otherwise indicated.

3.7 CLEANING

A. Progress Cleaning: Comply with cleaning during construction recommendations of NCMA TEK 8-4A "Cleaning Concrete Masonry."

1. Remove mortar droppings which adhere to exposed faces of masonry units with a trowel or chisel after mortar has hardened.
2. Remove remaining mortar with stiff fiber or bristle brush.
3. Remove grout spills immediately by washing and brushing.

B. Final Cleaning: Perform final cleaning according to ICMU manufacturer's recommendations.

END OF SECTION

SECTION 05 50 00 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Miscellaneous Metal Fabrications, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. ASTM International (ASTM):
    a. ASTM A27 Standard Specification for Steel Castings, Carbon, for General Application
    b. ASTM A36 Standard Specification for Carbon Structural Steel
    c. ASTM A47 Standard Specification for Ferritic Malleable Iron Castings
    d. ASTM A48 Standard Specification for Gray Iron Castings
    e. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
    f. ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
    g. ASTM A148 Standard Specification for Steel Castings, High Strength, for Structural Purposes
    h. ASTM A197 Standard Specification for Cupola Malleable Iron
    i. ASTM A307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
    j. ASTM A325 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
    k. ASTM A354 Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners
    l. ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
    m. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
    n. ASTM A668 Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
    o. ASTM A992 Standard Specification for Structural Steel Shapes
2. American Society of Mechanical Engineers (ASME):
    a. ANSI/ASME-A17.1 Handbook on Safety Code for Elevators and Escalators
3. American Institute of Steel Construction (AISC)
    a. Steel Construction Manual
4. American Iron and Steel Institute (AISI):
    a. Specification for the Design of Cold-Formed Steel Structural Members.

5. American Welding Society (AWS):

    a. ANSI/AWS C1.1M/C1.1 Recommended Practices for Resistance Welding
    b. ANSI/AWS D1.1 Structural Welding Code - Steel.
    c. ANSI/AWS D1.3 Structural Welding Code - Sheet Steel.

6. National Association of Architectural Metals Manufacturers (NAAMM):

    a. Class 1, Architectural, per NAAMM AMP-555, Code of Standard Practice for the Architectural Industry.

B. Provide Miscellaneous Metals Fabrications engineered to support dead, live, and lateral (wind or seismic) loads indicated.

1. Comply with Section 01 71 21, Specialty Engineering Requirements.
2. Include headers and reinforcing members around openings.
3. Required details defining method of fastening throughout system and attachments to supporting primary structure included in engineering requirement.

1.3 SUBMITTALS

A. Product Data:

1. For each type of material and accessory.

B. Shop Drawings:

1. Plans and elevations showing members and connections.
2. Anchors and accessory items.

C. Project Information:

1. Structural calculations for Miscellaneous Metals Fabrications indicating design conforms to specified design criteria, sealed by the Specialty Structural Engineer.
2. Submit concurrent with Shop Drawings.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Structural Steel:

1. Structural W and T shapes: ASTM A992, 50KSI yield point.
2. Other steel shapes and plate: ASTM A36.
3. Pipe: ASTM A53 Grade B.
4. Tubing: ASTM A500, Grade B, 46KSI minimum.

B. Cast Steel:

1. ASTM A27, Grade-65-35; and ASTM A148, Grade-80-50.

C. Steel Forgings:

1. ASTM A668.

D. Bolts:

1. ASTM A307, ASTM A325, ASTM A354.

E. Filler Metal:

1. AWS Standards.

F. Cast Iron:

1. ASTM A48, Class 30, minimum 30,000 PSI 206.8 MPa tensile.

G. Malleable Iron:

1. ASTM A47 and ASTM A197.

H. Aluminum:

1. ASTM B308 for particular alloy in standard shapes and extrusions.
2. ASTM B26 for castings.

I. Stainless Steel:

1. ASTM A484 and ASTM A276.
2. Concealed: Type 302 or Type 304.
3. Exposed: Type 316.
    a. Finish: ASTM A480 AISI finish No. 4, unless otherwise indicated.

J. Masonry Anchorage Devices:

1. Standard manufactured items.
2. Lead expansion shields for machine screws and bolts 1/4 IN 6 MM and smaller: Head out embedded nut type.
3. For machine screws and bolts larger than 1/4 IN 6 MM: Manufacturers' standard.
4. Bolt anchor expansion shields for lag bolts: Zinc alloy, long shield anchors.
5. Bolt anchor expansion shields for bolts: Closed end bottom bearing type.
6. Anchor to embed or set device in setting compound or epoxy grout where shown.

K. Fasteners:

1. Galvanized or stainless where built into exterior walls
2. Select fasteners for type, grade and class required
3. Bolts and Nuts: Regular hexagon head ASTM A307, Grade A
4. Lag Bolts: Square or octagonal head type
5. Machine Screws: Cadmium plated steel
6. Wood Screws: Flat head carbon steel
7. Plain Washers: Round carbon steel
8. Lock Washers: Helical spring carbon steel

L. Non-shrink Grout:

1. Compressive strength: 9000 PSI 62 MPa at 7 days.
2. Base Product: 1107 Advantage Grout by Dayton Superior.

M. Abrasive Warning Tape:

1. Self-adhering, tape with slip resistant mineral surface
2. Color: Safety Yellow
3. Width: 2 IN 50 MM, except where noted otherwise
4. Tape Type 2:
    a. Base Product: Safety-Walk 530 Conformable by 3M
    b. Backing: Aluminum foil
    c. Thickness: 0.035 IN 0.9 MM

d. Use Type 2 at top and bottom rungs of ladders

2.2 FABRICATION

A. Form to shapes indicated with straight lines, sharp angles, and smooth curves.

B. Shop fabricate in as large assemblies as practicable.

C. Anchorage Accessories:

1. Items required securing wood to metal, wood to masonry, metals to masonry or concrete, metal to metal or metal to other items.

D. Drill or punch holes with smooth edges for temporary field connections and attachment of work by other trades.

1. Conceal fastenings where practicable.

E. Make permanent shop and field connections with continuous fillet type welds.

1. Grind exposed welds smooth.

F. Supply items required to complete construction and installation.

G. Meet requirements specified under Structural Steel for fabricating items of structural nature or use.

2.3 FINISHES

A. Items not to receive coatings:

1. Surfaces scheduled to be fireproofed with spray-on material.
2. Machined surfaces.
3. Surfaces adjacent to field welds.
4. Contact surfaces of bolt connections at slip connections.
5. Top flanges of beams to receive shear connectors.
6. Items for which no coating or field finish is specified.

B. Shop Primer for Interior Non-wet Items:

1. Primer: Coordinate with field applied finish systems specified in Section 09 91 23.
2. Apply primer for interior finish paint to following surfaces not receiving other coating:

a. Surfaces exposed on interior.

3. Clean thoroughly before priming; remove mill scale, rust, dirt, oil, and grease in accordance with SSPC-SP3.
4. Apply in accordance with paint manufacturer’s instructions.

a. Apply minimum 0.002 IN 0.05 MM, dry film thickness.

C. Hot-dip Galvanized (HDG) Coating for Exterior Items:

1. Galvanize (HDG) the following items:

a. Items to be installed on site, roof or other areas that are outside of building enclosure walls. This shall include items attached to exterior walls of building.
b. Items to be installed in wet or humid (>70% RH) areas of building.

c. Partial listing of items to receive HDG:

1) Masonry lintels, ledge angles and shelf angles.
2) Pipe Bollards.
3) Exterior Ladders, Stairs and railings.
4) Exterior gratings and substructure.
5) Exterior equipment supports.
6) Similar items which are exposed to weather or built-in to Exterior walls.
7) Other items indicated.

2. Clean thoroughly before galvanizing.
3. Galvanize in accordance with ASTM A123.

D. Galvanizing Repair Coating:

1. Tnemec Series 94-H20 Hydro-Zinc.
2. ZRC Worldwide, Galvilite 221.
3. Sherwin Williams Zinc Clad III HS 100.

E. Finish Painting: 09 91 23

2.4 METAL FABRICATIONS

A. Ladders:

1. Design to comply with following regulations:

a. ANSI A14.3.
b. OSHA 29 1910.23.

2. Owner provides fall arrest system where desired or required.
3. Material:

a. Exterior Ladders: Galvanized steel, painted by Section 09 91 13.
b. Interior Ladders: Shop-primed steel, painted by Section 09 91 23.

4. Side rail members: Minimum 1/2 x 2 IN 13 x 25 MM.

a. Rail clip: Minimum 5/16 IN x 2 IN 8 MM x 25 MM, length as necessary.

5. Rungs: Minimum 3/4 IN 19 MM round or square bars.

a. Punch rungs through side rails and weld.

6. Size to support concentrated moving load of 200 LB 90.7 KG.
7. Minimum clearance from centerline of rung to wall or obstruction: 7 IN 180 MM.
8. Minimum ladder width: 16 IN 400 MM between side rails.
9. Rung spacing: 12 IN 300 MM O.C.
10. Apply abrasive warning tape Type 2 to top and bottom rung of ladders.
11. Ladder Safety Device:

a. OSHA compliant fall protection system.
b. Provided by Owner on ladders over 20 FT high.

B. Metal Gratings:

1. Complying with NAAMM Metal Bar Grating Manual.
2. Material and thickness (except were otherwise indicated):

a. Galvanized steel, nominal 1-1/2 IN 38 MM thick.

3. Load capacity: Support minimum uniform load of 200 PSF 10 kPa.
4. Provide hold down clips.
5. Furnish with frames and support items of comparable material and finish.

C. Steel Support Angles, Support Frames, and Loose Lintel Steel Members:

1. ASTM A36 steel, sizes and configurations as indicated.
2. Items to be hot dip galvanized:
    a. Items to be permanently exposed to weather, high humidity, or wet conditions.
    b. Items set into exterior walls.
3. Shop prime interior items not required to be galvanized.

D. Miscellaneous Equipment Supports:

1. ASTM A36 steel, Sizes and configurations as indicated.
2. Items to be hot dipped galvanized:
    a. Items to be permanently exposed to weather, high-humidity, or wet conditions.
    b. Items set into exterior walls.
3. Shop Prime interior items (in non-wet areas).

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify suitability of substrate to accept installation.

B. Installation constitutes acceptance of responsibility for performance.

3.2 INSTALLATION

A. General:

1. Set work level, true to line, plumb.
2. Weld field connections and grind smooth.
3. Conceal fastenings where practical.
4. Secure metal to wood with lag screws of adequate size with appropriate washers.
5. Secure metal to concrete with embedded anchors, setting compounds, caulking and sleeves, or setting grout.
    a. Use expansion bolts, toggle bolts, or screws for light duty service.
6. Meet structural requirements for erecting items of structural nature.
7. Do not field splice fabricated items unless size requires splicing.
8. Weld splices.
9. Provide fabricated items complete with attachment devices as required to install.

B. Galvanic Repair:

1. After galvanized units have been erected and anchored apply galvanizing repair paint in accordance with manufacturer’s recommendations.
2. Surface preparation: Remove contaminates in accordance with SSPC SP-1.

3.3 TOUCH-UP AND REPAIR

A. Verify installations are neat and flush in appearance, and that there are no burrs, projections, or defects on exposed surfaces that might snag fingers or clothing. Correct deficiencies.

B. Touch-up damage to powder coat finishes in manner satisfactory to Architect.

C. Galvanic Repair:

1. After galvanized units have been erected and anchored apply galvanizing repair paint in accordance with manufacturer's recommendations.
2. Surface Preparation: Remove contaminates in accordance with SSPC SP-1.

END OF SECTION

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SECTION 06 10 00 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Roofing related rough carpentry.
2. Wood blocking, cants, and nailers.
3. Wood furring and grounds.
4. Wood sleepers.
5. Plywood backing panels.

1.2 PRICE AND PAYMENT PROCEDURES

A. This specification Section shall be bid exactly as written. No substitutions, no changes in materials and no changes to fastener and anchor types will be considered.

1.3 DEFINITIONS

A. Boards or Strips: Lumber of less than 2 inches nominal (38 mm actual) size in least dimension.

B. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) size or greater but less than 5 inches nominal (114 mm actual) size in least dimension.

C. Exposed Framing: Framing not concealed by other construction.

D. OSB: Oriented strand board.

E. Timber: Lumber of 5 inches nominal (114 mm actual) size or greater in least dimension.

1.4 ACTION SUBMITTALS

A. Product Data: Technical data for each type of process and factory fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for fire retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
2. For fire retardant treatments, include physical properties of treated lumber both before and after exposure to elevated temperatures, based on testing by a qualified independent testing agency according to ASTM D 5664.
3. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

1.5 INFORMATIONAL SUBMITTALS

A. Material Certificates: Submit certificates for dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.

B. Evaluation Reports: Submit reports from ICC-ES:

1. Fire retardant treated wood.
2. Power driven fasteners.
3. Post installed anchors.
4. Metal framing anchors.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: For testing agency providing classification marking for fire retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

B. Coordination: Coordinate all Work with Roofing and roofing related Sections. All rough carpentry shall be installed to withstand the performance requirements of the roofing system, Roofing Specialties, Roof Accessories and Sheet Metal Flashing and Trim.

1. Coordinate all anchorages and fasteners to ensure only stainless steel fasteners are utilized.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.

1. Protect fire retardant materials against high humidity and moisture during storage and erection.

PART 2 - PRODUCTS

2.1 WOOD PRODUCTS

A. Lumber: DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Dress lumber, S4S, unless otherwise indicated.
3. Unless otherwise indicated, all wood products shall be Fire Retardant Treated Wood.

B. Maximum Moisture Content of Lumber: 15 percent.

2.2 FIRE RETARDANT TREATED MATERIALS

A. All rough carpentry materials shall be fire retardant treated unless specifically indicated in writing by the Architect.

B. Materials shall comply with requirements, that are acceptable to authorities having jurisdiction, and with fire test response characteristics specified determined by testing identical products per test method indicated by a qualified testing agency.

C. Fire Retardant Treated Lumber and Plywood by Pressure Process: Products with a flame spread index of 25 or less when tested according to ASTM E 84, and with no evidence of significant progressive combustion when the test is extended an additional 20 minutes, and with the flame front not extending more than 10.5 feet (3.2 m) beyond the centerline of the burners at any time during the test.

1. Treatment shall not promote corrosion of metal fasteners.
2. Exterior Type: Treated materials shall comply with requirements specified for fire retardant treated lumber and plywood by pressure process after being subjected to accelerated weathering according to ASTM D 2898. Use for exterior locations and where indicated.
3. Design Value Adjustment Factors: Treated lumber shall be tested according to ASTM D 5664 and design value adjustment factors shall be calculated according to ASTM D 6841. For roofing system related wood provide material with adjustment factors of not less than 0.85 modulus of elasticity and 0.75 for extreme fiber in bending for Project's climatological zone.

D. Kiln dry lumber after treatment to maximum moisture content of 19 percent. Kiln dry plywood after treatment to maximum moisture content of 15 percent.

E. Identify fire retardant treated wood with appropriate classification marking of qualified testing agency.

F. Application: Treat all rough carpentry unless otherwise indicated.

2.3 MISCELLANEOUS LUMBER

A. Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.
2. Nailers.
3. Rooftop equipment bases and support curbs.
4. Cants.
5. Furring.
6. Grounds.
7. Utility shelving.

B. Dimension Lumber Items: Construction or No. 2 grade lumber of any of the following species:

1. Hem-fir (north); NLGA.
2. Hem-fir; WCLIB or WWPA.
3. Western woods; WCLIB or WWPA.
4. Northern species; NLGA.
5. Eastern softwoods; NeLMA.

C. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

D. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent over nails and damage to paneling.

2.4 PLYWOOD BACKING PANELS

A. Equipment Backing Panels: Plywood, DOC PS 1, Exterior, A-C, fire retardant treated, in thickness indicated or not less than 3/4 inch (19 mm) nominal thickness.

2.5 FASTENERS

A. Fasteners: Size and type indicated complying with requirements specified for material and manufacture.

1. For all rough carpentry provide fasteners of Type 316 stainless steel.

B. Nails, Brads, and Staples: ASTM F 1667.

C. Post Installed Anchors: Stainless steel fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 ICC-ES AC58 ICC-ES AC193 or ICC-ES AC308 as appropriate for the substrate that will not degrade in contact with fire retardant treated materials.

1. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).

2.6 MISCELLANEOUS MATERIALS

A. Sill Sealer Gaskets, Provide where indicated: Closed cell neoprene foam, 1/4 inch (6.4 mm) thick, selected from manufacturer recommended widths to suit width of sill members indicated.

B. Flexible Flashing: Composite, self adhesive, flashing product consisting of a pliable, butyl rubber compound, bonded to high density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch (0.6 mm).

C. Adhesives for Gluing to Concrete or Masonry: Formulation complying with ASTM D 3498 that is approved for use indicated by adhesive manufacturer.

D. Water Repellent Preservative: NWWDA tested and accepted formulation containing 3-iodo-2-propynyl butyl carbamate, combined with an insecticide containing chloropyrifos as its active ingredient.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Framing Standard: Comply with AF&PA's WCD 1 Details for Conventional Wood Frame Construction, unless otherwise indicated.

B. Framing with Engineered Wood Products: Install engineered wood products to comply with manufacturer's written instructions.

C. Set rough carpentry to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate furring, nailers, blocking, grounds, and similar supports to comply with requirements for attaching other construction.

D. Install fire retardant treated plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels with classification marking of testing agency exposed to view.

E. Install sill sealer gasket to form continuous seal between sill plates and substrate.

F. Do not splice structural members between supports unless otherwise indicated.

G. Provide blocking and framing as indicated and as required to support facing materials, fixtures, appliances, wall mounted items, specialty items, and trim.

H. Provide fire blocking in furred spaces, stud spaces, and concealed cavities as indicated and as follows:

1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches (2438 mm) o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.

I. Sort and select lumber so natural characteristics do not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

J. Securely attach rough carpentry Work to substrate by anchoring and fastening as indicated, complying with the following:

1. Table 2304.9.1, Fastening Schedule, in ICC International Building Code (IBC).
2. ICC-ES evaluation report for fastener.

K. Use Stainless Steel Fasteners unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood. Drive nails snug but do not countersink nail heads unless otherwise indicated.

3.2 WOOD BLOCKING, AND NAILER INSTALLATION

A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces unless otherwise indicated.

C. Provide permanent grounds of dressed, pressure-preservative-treated, key-beveled lumber not less than 1-1/2 inches (38 mm) wide and of thickness required to bring face of ground to exact thickness of finish material. Remove temporary grounds when no longer required.

3.3 WOOD FURRING INSTALLATION

A. Install level and plumb with closure strips at edges and openings. Shim with wood as necessary for tolerance of finish work.

3.4 INSTALLATION OF BLOCKING AND NAILERS FOR ROOFING AND PARAPETS

A. General:

1. Comply with ANSI/SPRI ES-1.
2. Minimum Member Size: 2 inch by 6 inch nominal minimum unless exceeded on the Drawings.
3. Fasteners:
4. Stainless steel only; Do not use fasteners other than stainless steel for roof blocking, nailers, fasica and coping support and anchorage and all parapet construction.

    a. Countersink heads of all fasteners.
    b. Fastener types as required for substrate conditions.
    c. Diameter and spacing as required to resist forces indicated.

5. Fastener Spacing:

    a. Threaded Anchor Bolts; 3/8 inch or larger to meet roofing system Performance Requirements:

        1) Utilize 16mm 5/8 inch O.D. washers or larger.
        2) Maximum Spacing: 36 inches.
        3) Stagger 1/3 of the nailer width.

b. Other fastener types:

1) Maximum Spacing:

a) Typical: 12 inches O.C. typical
b) Up to 16 inches O.C. where necessary to match spacing of structural members.

2) Stagger 1/3 the nailer width.
3) At ends of nailers lengths (including butt ends and terminal ends): Install 2 fasteners and within 6 inches of ends.

6. Anchor nailers and blocking to resist minimum vertical force of 300 lbs/ft. in any direction.

a. Locate fasteners approximately 4 inches from ends but not less than 75mm 3 IN.
b. Use minimum of 3 anchors for each nailer section.
c. Where members are wider than 6 inches, stager fasteners from side to side to avoid splitting of the wood member; predrill as required to avoid splitting.
d. Corner region enhancements:

1) Double the above listed vertical force which must be resisted.
2) Length and width of corners as prescribed by ANSI/SPRI RP-4:

a) 40 percent of the building height, but not less than 8 feet.

B. Nailers used for perimeter securement of roofing membranes:

1. Install nailers where indicated and where required to secure perimeter of membrane roofing.
2. Match height of nailers to adjacent insulation.
3. Where multiple layers are required to match depth of insulation:

a. Attach base layer as indicated in the General paragraph in this Section.
b. Apply a bead of construction adhesive between all laminations.
c. Attach subsequent layers using fastener type which is appropriate for wood-to-wood anchorage to resist uplift.
d. Size and locate fasteners as required to resist uplift loading indicated.

C. Blocking used for securement of sheet metal edge flashings, parapet copings, and similar items:

1. Install blocking as indicated and as required to comply with this Section and all roofing system uplift requirements indicated in Section 07 54 00.

D. Metal Wall Backing: Specified in Section 05 40 00 for walls utilizing metal stud construction.

3.5 PROTECTION

A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron treated wood becomes wet, apply EPA registered borate treatment. Apply borate solution by spraying to comply with EPA registered label.

B. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA registered borate treatment. Apply borate solution by spraying to comply with EPA registered label.

END OF SECTION

SECTION 07 01 51 - ROOF MODIFICATIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Labor, materials and equipment necessary to complete the work of this Section, including – but not limited to – the following:

1. Roofing penetrations and remodeling of existing roofing to accommodate new work.
2. Protection of existing roofing during remodeling operations.
3. Preservation of the Owner's existing roofing warranty.

B. Products Installed but Not Furnished under This Section: Install the following items as furnished by the designated Sections:

1. Division 23 - Heating, Ventilating, and Air Conditioning:

a. Roof curbs, penetrations, and supports for HVAC equipment and piping.

1.2 RELATED REQUIREMENTS

A. Section 06 10 00 - Rough Carpentry: Wood nailers, curbs, and blocking.

B. Section 07 92 00 - Joint Sealants: Sealants.

1.3 DEFINITIONS

A. Roofing Terminology: Refer to ASTM D1079 and glossary of NRCA Roofing Manuals for definition of terms related to roofing work of this Section.

B. Roofing Terminology: Refer to ASTM D1079 and glossary of NRCA's Roofing Manuals. for definition of terms related to roofing work of this Section.

1.4 REFERENCES

A. ASTM D1079 - Standard Terminology Relating to Roofing and Waterproofing.

B. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.

C. FM 4470 - Single-Ply, Polymer-Modified Bitumen Sheet, Built-Up Roof (BUR) and Liquid Applied Roof Assemblies for use in Class 1 and Noncombustible Roof Deck Construction.

D. FM DS 1-29 - Roof Deck Securement and Above-Deck Roof Components; Factory Mutual System.

E. SMACNA (ASMM) - Architectural Sheet Metal Manual.

F. FM DS 1-49 - Perimeter Flashing, Factory Mutual System.

G. NRCA - The NRCA Roofing Manuals.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Conference: Conduct at Project site.

1. Comply with requirements in Section 01 30 00 - Administrative Requirements.

B. Meet with the Owner, testing and inspecting agency representative, roofing Installer, membrane roofing system manufacturer's representative, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.

C. Review methods and procedures related to roofing system including, but not limited to, the following:

1. Review methods and procedures related to roofing installation, including membrane roofing system manufacturer's written instructions.
2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
3. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
4. Review structural loading limitations of roof deck during and after roofing.
5. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing system.
6. Review governing regulations and requirements for insurance and certificates if applicable.
7. Review temporary protection requirements for roofing system during and after installation.
8. Review roof observation and repair procedures after roofing installation.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Installer Certificates: Signed by membrane roofing system manufacturer certifying that Installer is approved, authorized, or licensed by membrane roofing system manufacturer to install and modify roofing system.

C. Field Quality Control Reports:

1. Roofing system manufacturer’s inspection report(s). Include all pre-inspections, intermediate inspections and final report of completed roof installation.

1.7 QUALITY ASSURANCE

A. Source Limitations: Obtain components for roofing system from – or approved by – membrane roofing system manufacturer warranting the roof. Also, roofer executing modifications to the existing roof shall also be the installer of the new roofing on this Project.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.

B. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

1.9 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to membrane roofing system manufacturer's written instructions and warranty requirements.

1.10 WARRANTY

A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during remodeling, by methods and with materials so as not to void existing roofing system warranty. Notify warrantor before proceeding.

1. Notify warrantor of existing roofing system upon completion of reroofing, and obtain documentation verifying that existing roofing system has been inspected and warranty remains in effect. Submit documentation at Project closeout.

B. Roofing Installer’s Warranty: The roofing subcontractor shall supply Owner with a minimum two-year workmanship warranty for each roof. In the event any work related to the roofing, flashing, or metalwork is found to be defective within two years of substantial completion, the roofing installer shall remove and replace such at no additional cost. The roofing installer’s warranty obligation shall run directly to the building owner, and a signed copy of the roofing warranty shall be sent to the membrane roofing system manufacturer.

PART 2 - PRODUCTS

2.1 ROOFING ASSEMBLY MATERIALS

A. Roofing Materials: Match existing. Engage services of a roofing consultant if type of roof and roof assembly cannot be readily determined. Provide auxiliary materials compatible with membrane roofing and recommended by membrane roofing system manufacturer for intended use.

B. Fasteners: Factory-coated steel fasteners and metal or plastic plates meeting corrosion-resistance provisions in FM 4470, designed for fastening membrane to substrate, and acceptable to membrane roofing system manufacturer.

C. C. Miscellaneous Accessories: Provide the following.

1. Pourable sealers.
2. Preformed cone and vent sheet flashings.
3. Preformed inside and outside corner sheet flashings.
4. T-joint covers.
5. In-seam sealants.
6. Termination reglets.
7. Cover strips.
8. Other accessories.

2.2 PERFORMANCE REQUIREMENTS

A. General: Provide installed roofing membrane and base flashings that remain watertight and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure. Do not permit the passage of water.

B. Material Compatibility: Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by membrane roofing system manufacturer, based on testing and field experience. All membrane materials shall match those of the system under warranty; all vapor retarder materials shall be ASTM E2178 tested and have a perm rating of no less than 0.02 perm.

C. Roofing System Design: Roofing system shall be designed to withstand Code-required loads and wind speeds.

D. Flashings: Provide base flashings, perimeter flashings, detail flashings, and component materials that comply with requirements and recommendations in the following, as applicable.

1. For Above Deck Roof Components: FM DS 1-29.
2. For Perimeter Flashings: FM DS 1-49.
3. For Construction Details:

    a. NRCA Roofing Manuals.
    b. SMACNA (ASMM).

2.3 WALKWAYS

A. Flexible Walkways at New Equipment: Factory-formed, nonporous, heavy-duty, solid-rubber, slip-resisting, surface-textured walkway pads or rolls approximately 3/16 inch thick, and acceptable to membrane roofing system manufacturer.

1. Pads or rolls shall be installed over an added sacrificial layer of roofing membrane matching the roofing system. Adhere or weld roofing membrane in place.

2.4 ROOF SYSTEM AND COMPONENT ASSEMBLY PROTECTION

A. All roof components and component system installations shall be fully protected against puncture, marring and other damage by materials, personnel, equipment, temporary supports or any other materials, equipment or other construction activities for the full duration of construction and until Final Completion.

B. Protection shall consist of a minimum of 1 inch thick extruded polystyrene board insulation, ASTM C578, Type IV with 3/4 inch CDX plywood cover for the entire roof area where construction activities occur.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with conditions affecting performance of roofing system.

1. Verify that roof openings and penetrations are in place and set and braced – and that roof drains are securely clamped in place.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Moisture Testing: Perform tests recommended by membrane roofing system manufacturer and as follows. Proceed with installation only after substrates pass testing.

1. Relative-humidity probe and digital meter method according to ASTM F2170.
2. Proceed with installation only after substrates have a maximum relative-humidity-measurement reading of less than 75 percent in 72 hours.

3.2 PREPARATION AND INSTALLATION

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to membrane roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.

C. Install roofing membrane over area to receive roofing according to membrane roofing system manufacturer's written instructions. Unroll roofing membrane and allow to relax before installing.

D. Repair tears, voids, and lapped seams in roofing that does not meet requirements.

E. Install sheet flashings and preformed flashing accessories and adhere to substrates according to membrane roofing system manufacturer's written instructions.

F. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

G. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.

H. Terminate and seal top of sheet flashings.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Services: At the start of the installation, periodically as the Work progresses, and after completion, furnish the services of the roofing manufacturer's technical representative at the job site as necessary to advise on every phase of the Work. As a minimum, furnish representative attendance prior to cutting away any roof materials or beginning any alteration Work, during installation of roofing system repair and as may be required or recommended by the roofing system manufacturer to uphold the warranty. The representative shall examine the roofing substrates before installation of the vapor retarder as well as examine the completed vapor retarder installation before it is covered.

1. Vapor retarder: Inspect the vapor retarder during installation to assure full adhesion and manufacturer's quality requirements are maintained throughout the installation period. If vapor retarder is utilized as a temporary roof, the manufacturer’s representative shall inspect the vapor retarder prior to the installation of the remaining roof assembly to ensure the integrity of the vapor retarder system. Perform any and all repairs recommended by the manufacturer’s representative prior to continuing installation.
2. Fastener Tests: Perform two fastener pull out tests per SPRI FX-1 test procedure to verify the integrity of the roofing fasteners and compliance with required performance criteria.
3. Securement Tests: Perform two membrane adhesive pull tests according to SPRI IA-1 to verify the integrity of the roof membrane adhesive and compliance with the required performance criteria.
4. Field Seams: Inspect the field seams to assure manufacturer's quality requirements are maintained throughout the installation period. Each field seam shall be 100% inspected and a written report prepared by the roofing manufacturer's technical representative shall be submitted for review prior to final acceptance.
5. Coordinate final inspections by the roofing membrane Manufacturer shall be coordinated at least two weeks in advance with the Owner, Architect, and roofing consultant so that their attendance can be properly coordinated. Final inspection reports and signed, completed punch list reports by the Manufacturer shall be submitted to the Owner. Submittal of the roofing warranty alone is not acceptable.

B. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report.

3.4 WALKWAY INSTALLATION

A. Flexible Walkways: Install walkway products in locations indicated. Pads or rolls shall be installed over an added sacrificial layer of roofing membrane matching the roofing system. Adhere or weld roofing membrane in place. Adhere walkway products to substrate with compatible adhesive according to membrane roofing system manufacturer's written instructions.

3.5 FIELD QUALITY CONTROL

A. Accompany the manufacturer’s technical inspector, and assist with equipment and workmen if necessary to provide access to the roof. Correct defects noted during construction.

B. Testing Agency: Engage a qualified independent testing and inspecting agency to perform roof tests and inspections and to prepare test reports.

C. Repair or remove and replace components of membrane roofing system where test results or inspections indicate that they do not comply with specified requirements.

D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.6 PROTECTING AND CLEANING

A. Protect roofing system from damage and wear during remainder of construction period.

1. Special permission shall be obtained from the roofing system manufacturer before any traffic shall be permitted over new roofing. Where traffic must continue over finished roof membrane, protect surfaces using durable materials as recommended by the roofing system manufacturer.
2. When remaining construction will no longer affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Owner.
3. Correct deficiencies in – or remove – membrane roofing system that does not comply with requirements. Repair substrates – and repair or reinstall membrane roofing system – to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

B. Roof system and component protection installation:

1. Protect all roof components and partial system installations against puncture and other damage by materials, material staging and transportation, personnel, equipment, temporary supports or any other materials, equipment or other construction activities for the full duration of construction and until Final Completion.
2. Lay specified insulation board over installed roof system or related components for full area. Utilize full size boards without mechanical fasters or adhesive. Stagger all seams at half-board running bond type pattern and cover with 3/4 inch CDX plywood as specified. Plywood cover shall also be placed with

staggered seams at half-board running bond type pattern without mechanical fasteners or adhesive. Ensure seams of insulation and plywood are no greater than 1/8 inch in all areas. Provide sand bag weights at seams or other intervals to guard against uplift and shifting of protection materials. Protection shall remain in place for the duration of all construction activities.

3. When protection is removed, the entire area shall be swept to collect and remove fasteners and other small items which may cause penetrations in the roofing system or components. Remove all foreign items from the roof area and provide thorough cleaning to remove any deleterious items, marring, surface defects or discoloration of the finished system.

C. Clean all overspray and spillage from adjacent construction using cleaning agents and procedures ONLY as recommended by manufacturer of affected construction.

END OF SECTION 07 01 51

SECTION 07 13 26 - SELF ADHERING SHEET WATERPROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Modified bituminous sheet waterproofing.

1.2 ACTION SUBMITTALS

A. Product Data: Technical data for each type of product, including include construction details, material descriptions, and tested physical and performance properties of waterproofing.

1. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.

B. Shop Drawings: Show locations and extent of waterproofing and details of substrate joints and cracks, sheet flashings, penetrations, inside and outside corners, tie-ins with adjoining waterproofing, and other termination conditions.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: Submit installer’s qualifications.

B. Field quality control reports.

C. Sample Warranty: Copy of special waterproofing manufacturer's and Installer's warranty stating obligations, remedies, limitations, and exclusions before starting waterproofing.

1.4 CLOSEOUT SUBMITTALS

A. Executed copy of Special Manufacturer’s Warranty.

B. Executed copy of Special Installer’s Warranty.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An entity having minimum 5 years documented experience and employs installers and supervisors who are trained and approved by waterproofing manufacturer.

B. Source Limitations for Waterproofing System: Obtain waterproofing materials, protection course, and molded sheet drainage panels from single source from single manufacturer.

C. Mockups: Build mockups to verify selections made under Sample submittals and to set quality standards for installation.

1. Build for each typical waterproofing installation including accessories to demonstrate surface preparation, crack and joint treatment, corner treatment, and protection.

   a. Size: 200 square feet in area minimum with corner and footing conditions As shown on Drawings or in area selected by the Architect.
   b. Description: Each type of installation.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

D. Preinstallation Conference: Conduct conference at site.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended in writing by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.

1. Do not apply waterproofing in snow, rain, fog, or mist.

B. Maintain adequate ventilation during preparation and application of waterproofing materials.

1.7 WARRANTY

A. Written warranty signed by manufacturer in which manufacturer agrees to furnish replacement waterproofing material for waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

B. Written warranty signed by Installer in which Installer agrees to warrant its work.

1. Warranty Period: Two years from the date of Substantial Completion.
2. Warranty includes removing and reinstalling protection board, drainage panels, insulation, pedestals, and pavers on plaza decks.

PART 2 - PRODUCTS

2.1 MODIFIED BITUMINOUS SHEET WATERPROOFING

A. Modified Bituminous Sheet: Minimum 60 mil (1.5 mm) nominal thickness, self adhering sheet consisting of 56 mils (1.4 mm) of rubberized asphalt laminated on one side to a 4 mil (0.10 mm) thick, polyethylene film reinforcement, and with release liner on adhesive side; formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction.

1. Basis of Design: Provide Bituthene System 4000 by GCP Applied Technoogy. Subject to compliance with requirements, and determination of an equivalent system by the Architect, provide products by one of the following may also be acceptable:

    a. American Hydrotech, Inc.
    b. Carlisle Coatings & Waterproofing Inc.
    c. CETCO, a Minerals Technologies company.
    d. Henry Company.
    e. Polyguard Products, Inc.
    f. Protecto Wrap Company.
    g. W. R. Meadows, Inc.

2. Physical Properties:

    a. Tensile Strength, Membrane: 250 psi (1.7 MPa) minimum; ASTM D 412, Die C, modified.
    b. Ultimate Elongation: 300 percent minimum; ASTM D 412, Die C, modified.
    c. Low Temperature Flexibility: Pass at minus 20 degrees F (minus 29 degrees C); ASTM D 1970.
    d. Crack Cycling: Unaffected after 100 cycles of 1/8 inch (3-mm) movement; ASTM C 836.
    e. Puncture Resistance: 40 lbf (180 N) minimum; ASTM E 154.
    f. Water Absorption: 0.2 percent weight-gain maximum after 48-hour immersion at 70 degrees F (21 degrees C); ASTM D 570.
    g. Water Vapor Permeance: 0.05 perms (2.9 ng/Pa x s x sq. m) maximum; ASTM E 96/E 96M, Water Method.
    h. Hydrostatic Head Resistance: 200 feet (60 m) minimum; ASTM D 5385.

3. Sheet Strips: Self adhering, rubberized asphalt strips of same material and thickness as sheet waterproofing.

2.2 AUXILIARY MATERIALS

A. Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing and specific applications.

1. Furnish liquid type auxiliary materials that comply with VOC limits of authorities having jurisdiction.

B. Primer: Liquid waterborne primer recommended for substrate by sheet waterproofing material manufacturer.

C. Surface Conditioner: Liquid, waterborne surface conditioner recommended for substrate by sheet waterproofing material manufacturer.

D. Liquid Membrane: Elastomeric, two component liquid, cold fluid applied, of trowel grade or low viscosity.

E. Substrate Patching Membrane: Low viscosity, two component, modified asphalt coating.

F. Epoxy Seal: Recommended by waterproofing system manufacturer.

G. Sealants, Mastic, Adhesives, and Detail Tape: Sealeants, Liquid mastic and adhesives, and adhesive tapes recommended by waterproofing manufacturer for the specific conditions of each application and to uphold the warranty.

1. Detail Tape: For covering joints. cut edges, roll ends, penetrations and detailing.
2. Flashing: As recommended by waterproofing manufacturer for the specific conditions of each application.

H. Metal Termination Bars: Aluminum bars, approximately 1 inch by 1/8 inch (25 mm by 3 mm), predrilled at 9 inch (229 mm) centers.

1. Fasteners: Stainless steel or aluminum recommended by system manufacturer.

a. Fasteners to Concrete Substrates: 1/4 inch (25 mm) diameter minimum impact anchor with plastic expansion body and stainless steel drive pin of lengths to provide a minimum of 1-1/2 inch (38 mm) embedment into substrate. Provide compatible washers necessary to engage termination bar.

2. Hose Clamp: Stainless steel, worm drive.

I. Waterstop:

1. Hydrophilic Waterstop: Nonmoving concrete joints compatible with waterproofing membrane and included in system warranty.

a. Manufacturer: Subject to compliance with requirements, provide products of one of the following:

1) ADCOR Hydrophilic Waterstop by GCP Applied Technologies.
2) Sika Hydrotite by Sika Corp.

2. Injectable Waterstop: System that provides a conduit for placement of chemical grouts for permanent sealing interfaces and voids within construction joints, pipe penetrations, and wall and slab connections.

a. Permeable tube, 1/2 inch (13 mm) for injecting chemical grouts.

J. Chemical Grout: Provide one of the following as applicable to installation conditions.

1. Flex SLV Pure by De Neef, GCP Applied Technologies: Ultra low viscosity hydrophobic polyurethane for injecting into hairline cracks in concrete structures.
2. Flex LV Pure by De Neef, GCP Applied Technologies: Hydrophobic polyurethane forming flexible gasket when injected into cracks and joints in concrete structures; expanding on contact with water and curing to flexible foam resistant to organic solvents, mild acids, alkali, petroleum and microorganisms.
3. Superflex AR by De Neef, GCP Applied Technologies: System composed of methacrylic acrylate copolymer resin and reinforcing agent for a low viscosity injectable grout for injecting into pores, capillaries, hairline cracks, and honeycombed concrete.

K. Cementitious Grout: ASTM C 827; type recommended by waterproofing manufacturer; nonshrink, nonmetallic, premixed, nonstaining, noncorrosive grout suitable for feathered edge.

2.3 PROTECTION COURSE

A. Protection Course: Extruded polystyrene board insulation, unfaced, ASTM C 578, Type X, 1/2 inch (13 mm) thick.

2.4 MOLDEDSHEET DRAINAGE PANELS

A. Nonwoven Geotextile Faced, Molded Sheet Drainage Panel with Polymeric Film: Composite subsurface drainage panel acceptable to waterproofing manufacturer and consisting of a studded, nonbiodegradable, molded plastic sheet drainage core; with a nonwoven, needle punched geotextile facing with an apparent opening size not exceeding No. 70 (0.21 mm) sieve laminated to one side of the core and a polymeric film bonded to the other side; and with a vertical flow rate through the core of 9 to 21 gpm per ft. (112 to 261 L/min. per m).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. American Hydrotech, Inc.
    b. Carlisle Coatings & Waterproofing Inc.
    c. Grace Construction Products.
    d. Protecto Wrap Company.

B. Molded Sheet Collector Panel System Wrapped with Geotextile: Composite subsurface collector panel system by same manufacturer as primary molded sheet drainage panels; consisting of high profile, studded, nonbiodegradable, molded plastic sheet drainage core; wrapped with nonwoven geotextile facing with an apparent opening size not exceeding No. 40 (0.425-mm) sieve; and with a vertical flow rate through the core of 21 to 97 gpm per ft. (261 to 1197 L/min. per m) and minimum horizontal, in-plane flow rate of 21 gpm per ft. (261 L/min. per m). Provide system with manufacturer's outlets, connectors, tapes, and accessories to connect primary molded sheet drainage panels with piped subdrainage system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and conditions affecting performance of waterproofing.

1. Verify concrete has cured and aged for minimum time period recommended in writing by waterproofing manufacturer.
2. Verify substrate is visibly dry and within the moisture limits recommended in writing by manufacturer. Test for capillary moisture by plastic sheet method in accordance with ASTM D 4263.
3. Verify that compacted subgrade is dry, smooth, sound, and ready to receive waterproofing sheet.

B. Proceed with installation after correcting unsatisfactory conditions.

3.2 PREPARATION

A. Clean, prepare, and treat substrates in accordance with manufacturer's written instructions. Provide clean, dust free, and dry substrates for waterproofing application.

B. Mask off adjoining surfaces not receiving waterproofing to prevent spillage and overspray affecting other construction.

C. Remove grease, oil, bitumen, form release agents, paints, curing compounds, and penetrating contaminants or film forming coatings from concrete.

D. Remove fins, ridges, mortar, and projections and fill honeycomb, aggregate pockets, holes, and other voids.

E. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks in accordance with ASTM D 4258.

1. Install sheet strips of width in accordance with manufacturer's written instructions and center over treated construction and contraction joints and cracks exceeding a width of 1/16 inch (1.6 mm)**.**

F. Bridge and cover isolation joints, expansion joints, and discontinuous deck to wall and deck to deck joints with overlapping sheet strips of widths in accordance with manufacturer's written instructions.

1. Invert and loosely lay first sheet strip over center of joint. Firmly adhere second sheet strip to first and overlap to substrate.

G. Corners: Prepare, prime, and treat inside and outside corners in accordance with ASTM D 6135.

1. Install membrane strips centered over vertical inside corners. Install 3/4 inch (19 mm) fillets of liquid membrane on horizontal inside corners and as follows:

a. At footing to wall intersections, extend liquid membrane in each direction from corner or install membrane strip centered over corner.
b. At plaza deck to wall intersections, extend liquid membrane or sheet strips onto deck waterproofing and to finished height of sheet flashing.

H. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions in accordance with ASTM D 6135.

3.3 MODIFIED BITUMINOUS SHEET WATERPROOFING APPLICATION

A. Install modified bituminous sheets in accordance with waterproofing manufacturer's written instructions and per recommendations in ASTM D 6135.

B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Reprime areas exposed for more than 24 hours.

C. Apply and firmly adhere sheets over area to receive waterproofing. Accurately align sheets and maintain uniform 2-1/2 inch (64 mm) minimum lap widths and end laps. Overlap and seal seams, and stagger end laps to ensure watertight installation.

1. When ambient and substrate temperatures range between 25 degrees F and 40 degrees F (minus 4 degrees C and plus 5 degrees C), install self adhering, modified bituminous sheets produced for low temperature application. Do not use low temperature sheets if ambient or substrate temperature is higher than 60 degrees F (16 degrees C).

D. Install sheet waterproofing and auxiliary materials to tie into adjacent waterproofing where applicable.

E. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending 6 inches (150 mm) beyond repaired areas in all directions.

F. Seal penetrations through membrane with additional stripping making positive seal with penetrating members. Seal around items and surfaces projecting through waterproofed surfaces. Ensure sealed areas are watertight.

G. Protection Course: Immediately install protection course with butted joints over waterproofing membrane. Apply protection board the same day membrane is applied. Apply mastic at rates recommended by manufacturer.

1. Apply protection board with long dimension vertical with joints lapped 6 inches (150 mm) minimum and end laps offset 6 inches (150 mm) in succeeding courses to result in a maximum of 3 layers of board at corners. Seal laps with 1/16 inch (1.6 mm) thick trowel application of adhesive. Neatly fit boards around pipes and projections.
2. Do not leave board exposed above grade line. Protect from damage until backfill is placed.

3.4 MOLDED SHEET DRAINAGE PANEL INSTALLATION

A. Place and secure molded sheet drainage panels, with geotextile facing away from wall or deck substrate, in accordance with manufacturer's written instructions. Use adhesive or another method that does not penetrate waterproofing. Lap edges and ends of geotextile to maintain continuity. Protect installed molded sheet drainage panels during subsequent construction.

1. For vertical applications, install protection course before installing drainage panels unless otherwise indicated on the Drawings.

3.5 FIELD QUALITY CONTROL

A. Manufacturer Field Service: Engage a full time site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components; and to furnish daily reports to Architect.

B. Waterproofing will be considered defective if it does not pass inspections.

C. Prepare test and inspection reports.

3.6 PROTECTION, REPAIR, AND CLEANING

A. Do not permit foot or vehicular traffic on unprotected membrane.

B. Protect waterproofing from damage and wear during remainder of construction period.

C. Protect installed insulation drainage panels from damage due to UV light, harmful weather exposures, physical abuse, construction equipment damage and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

D. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.

E. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended in writing by manufacturer of affected construction.

END OF SECTION

SECTION 07 53 25 - FULLY ADHERED EPDM ROOFING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Fully Adhered EPDM Roofing in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Installer Qualifications:

1. Manufacturer authorized roofing installer.

B. Component products produced by single manufacturer or approved for use by roofing manufacturer to achieve a warranted system.

C. ASTM International (ASTM):

1. ASTM C1177 Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing
2. ASTM C1289 Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board
3. ASTM C1303 Standard Test Method for Predicting Long-Term Thermal Resistance of Closed-Cell Foam Insulation
4. ASTM D312 Standard Specification for Asphalt Used in Roofing
5. ASTM D4637 Standard Specification for EPDM Sheet Used in Single-Ply Roofing
6. ASTM D4811 Standard Specification for Non-vulcanized Rubber Sheet Used as Roof Flashing
7. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials
8. ASTM E96 Standard Test Methods for Water Vapor Transmission of Materials

D. American National Standards Institute (ANSI) / Single Ply Roofing Industry (SPRI):

1. ANSI/SPRI ES-1 Wind Design Standard for Edge Systems Used with Low Slope Roofing Systems

E. National Roofing Contractors Association (NRCA):

1. Roofing and Waterproofing Manual

F. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):

1. Architectural Sheet Metal Manual

G. Underwriters Laboratories (UL):

1. 790, Standard for Tests for Fire Resistance of Roof Covering Materials

H. Concrete Moisture Vapor Testing:

1. Coordinate maximum moisture allowed in concrete deck with roofing manufacturer.
2. Test concrete decks for moisture in accordance with Section 07 16 04.

3. If moisture content exceeds manufacturer's recommendation, install moisture control system per Section 07 16 05.

I. Static pressure of building interior: Less than 0.5 IN water.

J. Fire Resistance Rating:

1. UL 790, Class A.
2. Assembly in conformance with fireproofing as specified.

K. Preinstallation Conference:

1.3 SUBMITTALS

A. Shop Drawings:

1. Roof layout showing insulation thicknesses and details.
2. Detail and indicate location of expansion joints, crickets, saddles, curbs, safety tiebacks, vents, drains and other penetrations.
3. Indicate slope direction, slope amount, and key vertical elevation points.
4. Indicate components included for installation including anchor plate configuration.
5. Profiles of flashing assemblies.
6. Installation drawings.

B. Product Data:

1. Manufacturer standard literature for vapor barrier, insulation and roofing system components, including adhesives and accessories indicating compliance with specification requirements.
2. Manufacturer standard literature for roof coping system indicating components and accessories including anchor plate configuration.

C. Samples:

1. Roofing manufacturer's facsimile of each sheet metal color for pre-selection.
2. 3 IN x 5 IN samples of roofing manufacturer's sheet metal color for final approval.

D. Project Information:

1. Minutes from Preinstallation Conference.

E. Contract Closeout Information:

1. Warranty.
2. Maintenance Data:

a. Include cleaning instruction.

1.4 WARRANTY

A. Manufacturer's standard fifteen (15) year warranty of weathertightness signed by roofing materials manufacturer.

1. Warranty to include coverage for peak gusts of wind to:

a. 55 MPH at 33 FT above ground.

2. Warranty to include the entire system: membrane, flashings, adhesives, sealants, counterflashings, insulation, fasteners, fastener plates, fastener strips, hard rubber

or metal edging, metal termination bars, sheet metal copings and edge metal, and other material authorized by manufacturer.

B. Manufacturer's twenty (20) year warranty on 70% PVDF, Kynar 500, coatings on edge metal and copings.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Fully Adhered EPDM Roofing:

1. Basis of Design:

a. Carlisle SynTec Systems

2. Optional:

a. Firestone Building Products
b. Johns Manville

B. Sheathing:

1. Basis of Design:

a. Georgia-Pacific.

2. Optional:

a. Same as roofing manufacturer.
b. USG Corporation.
c. National Gypsum.

C. Vapor Retarder (VR):

1. Basis of Design:

a. Same as roofing manufacturer.

D. Sheet Metal Coping and Edge Metal:

1. Basis of Design:

a. Same as roofing manufacturer.

E. Other Materials:

1. Basis of Design:

a. Manufacturers as noted.

F. Other manufacturers desiring approval comply with Section 01 61 00.

2.2 DESIGN CRITERIA

A. Determine per Wind Load Design Guide for Low Sloped Flexible Membrane Roofing Systems published by SPRI.

B. Design roof system and anchorage fastener type and spacing needed to resist uplift pressures including roof covering and metal edge securement to meet design loads and satisfy requirements of applicable building codes, local amendments, and ANSI/SPRI ES-1.

C. Wind loads: Use the greater of the following:

1. Wind pressures as required per local building code based on wind speed, exposure factor and importance factor noted in Structural Drawings.

D. Requirements applicable to designated warranty.

E. Roof height and parapet height: As indicated.

F. Static pressure of building interior: Less than 0.5 IN water.

2.3 MATERIAL

A. Sheathing:

1. Install over steel deck or existing roofing materials.
2. Moisture resistant gypsum core with fiberglass mat and non-asphaltic surfacing.
3. Minimum Thickness: 5/8 IN.
4. DensDeck Prime Roof Board by Georgia-Pacific.

B. Vapor Retarder:

1. Rubberized asphalt membrane adhered to polyethylene or polyolefin top sheet.
2. 30 MIL thick, minimum.
3. Vapor Permeance: Not exceeding 0.05 Perm US.
4. Primer or adhesive as recommended for substrate by manufacturer.
5. 725TR by Carlisle SynTec Systems

C. Roof Insulation:

1. Furnished by roofing manufacturer.
2. UL listed for assembly indicated.
3. Provide crickets and saddles as required.
4. Polyisocyanurate (PISO) roof insulation:
    a. Rigid, closed cell foam core bonded to heavy-duty glass fiber mat facers.
    b. ASTM C1289 Type II, Class 1.
    c. R-value: 5.6 per inch 1 per 25 MM in accordance with ASTM C1303, CAN/ULC S770.
    d. Compressive strength: 25 PSI 170 kPa minimum per ASTM D1621, Grade 3.
    e. Dimensional stability: 2% maximum linear change in seven days per ASTM D2126.
    f. Minimum insulation thickness:
        1) Areas where tapered insulation is indicated:
            a) Minimum R-30 RSI-5.3 at roof drains.
            b) Taper to provide slope of 1/4 IN per FT 1 MM per 48 MM.
        2) Areas with uniform insulation thickness (sloped structures):
            a) Minimum R-30 RSI-5.3 at roof drains.
5. InsulBase polyisocyanurate by Carlisle SynTec Systems.

D. Cover Board:

1. Moisture resistant gypsum core with fiberglass mat and non-asphaltic surfacing.

2. Minimum Thickness: 5/8 IN.
3. DensDeck Prime Roof Board by Georgia-Pacific.

E. Roofing Membrane:

1. Ethylene propylene diene terpolymer (EPDM).
    a. Comply with ASTM D4637.
2. Non-reinforced.
    a. Comply with ANSI/RMA IPR-1.
3. Minimum Physical Properties:
    a. Thickness: 60 MIL.
    b. Tensile Strength: 1305 PSI minimum by ASTM D412.
    c. Ultimate Elongation: 350% minimum by ASTM D412.
    d. Tearing Strength: 175 LBS minimum by ASTM D624, Die C.
    e. Factory Seam Strength: Tested to membrane rupture by ASTM D816, modified.
    f. Fire Retardant.
    g. Color: White (White-on-black).
4. Sure-Seal by Carlisle SynTec Systems.

F. Membrane Flashings, Fasteners, Adhesives, Tapes and Sealants:

1. Roofing manufacturer's standard.

G. Edge Metal and Coping:

1. Roofing manufacturer's pre-engineered, prefabricated system for termination of roofing membrane.
2. Obtain approval in writing by roofing manufacturer for field fabricated components to ensure a warranted system.
3. Design for wind pressure indicated for balance of roof system.
4. Conceal fasteners from view.
5. Conceal splice plates, with color matching snap-on covers.
6. Anchor cleats:
    a. Material: G90 galvanized steel.
    b. Thickness: 20 GA.
7. Snap-on cover:
    a. Material: G90 galvanized steel.
    b. Thickness:
        1) For dimensions less than 10 IN: 24 GA.
        2) For dimensions 10 to 24 IN: 22 GA.
    c. Finish: 70% PVDF Kynar 500.
    d. Color:
        1) To be selected from manufacturer's standard colors by Architect.
8. Roof Edge/Fascia:

a. Include accessories such as pre-fabricated inside and outside corners, spill out, overflow and downspout scuppers, edging extensions, fascia sumps, and other items indicated.
b. SecurEdge 200 Fascia by Carlisle SynTec Systems.

9. Coping:

a. Include accessories such as pre-fabricated inside and seamed outside corners, end caps, saddles, tees, crosses, transition pieces and radius copings, and other items indicated.
b. SecurEdge 200 Coping by Carlisle SynTec Systems.

H. Fasteners:

1. Type, spacing and quantity as recommended by manufacturer.

a. Designed to resist uplift forces generated by specified wind speed.

2. Minimum pullout values per fastener:

a. For use with 22 GA steel decks: 350 LBS each.
b. For use with normal weight concrete decks: 800 LBS each.

3. Fasteners shall be capable of providing a static back-out resistance of at least 10 IN-LBS.

I. Elastic Roof Expansion Joint Covers:

1. Metal flanged elastic-sheet bellows-type joint system, membrane, and metal flanges compatible with substrate.
2. Aluminum Finish: Fluoropolymer, 2-coat.

J. Molded Walkway Pads:

1. Molded rubber walkway pad with slip resistant surface.
2. Color: Same as membrane.
3. Nominal Thickness: 3/16 IN.
4. Length and Width: 30x30 IN.
5. Include adhesive or pressure-sensitive tape as recommended by membrane manufacturer.
6. Locate where indicated.

a. Do not locate within 10 FT of roof edge.

K. Miscellaneous Items:

1. Roofing accessories:

a. Use manufacturer's standard prefabricated accessories where available.
b. Nailing strips: As detailed and required.
c. Pipe flashings: Provide for each pipe penetration; include clamps, adhesive and sealants.
d. Expansion joint covers.
e. Underlayment for pavers: As recommended by roofing manufacturer.

2. Adhesives, cleaners, and primers: As recommended by roofing manufacturer.
3. Fire-retardant Treated (FRT) wood blocking: Specified in Section 06 10 00.
4. Other materials as required by manufacturer for complete system warranty.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Inspect entire area to be roofed for acceptability.

B. Surface on which insulation or roofing membrane is applied shall be clean, smooth, dry, and free of projections such as fins, sharp edges or foreign materials.

C. Correct unsatisfactory conditions.

D. Commencement of roofing activities constitutes acceptance of conditions affecting installation and roofing system performance.

3.2 INSTALLATION

A. Sheathing:

1. Install per UL requirements.
2. Lay sheathing tightly butted and cut to fit around penetrations.
3. Attach sheathing to deck in accordance with roofing manufacturer's recommendations.

B. Vapor Retarder:

1. Install in largest practical widths.
2. Bond vapor retarder to substrate using approved adhesive.
3. Install continuously.
    a. Ensure surfaces to be taped are clean and dry.
    b. Ensure that no discontinuities occur, including at seams, penetrations, and edge terminations.
    c. Join sections of vapor retarder and lap seams in direction of water flow.
    d. Continuously seal roof vapor retarder to wall air and moisture retarder.
4. Seal around pipes, conduits, curbs, safety tie-backs, and other penetrations with pipe boots in accordance with manufacturer's instructions.
5. Maintain continuity of vapor retarder over expansion joints.
6. Repair holes in vapor retarder with method and material recommended by manufacturer.
7. Protect vapor retarder from damage until covered with insulation.

C. Wood Nailers:

1. Design to resist a minimum of 200 LBS/LF in any direction per SPRI Test Method RE-1.
2. Provide where indicated or required for proper securement of roofing system.
3. Install top of blocking flush with top of insulation.

D. Insulation:

1. Attach with adhesive in full spray or beads, or mechanically attach with fasteners in accordance with roofing manufacturer's recommendations.
2. Where required thickness of insulation is greater than 2 IN, install insulation in at least 2 layers.
3. Cut insulation neatly to fit around roof penetrations and projections.
4. Butt joints tightly.

5. Install overlay board over insulation.
    a. Fasten through overlay board and insulation to deck.

E. Cover Board:
1. Install cover board continuously over insulation.
2. Secure to substrate in same manner specified for insulation securement.

F. Membrane:
1. Do not allow grease, fats, oils and other contaminants to contact roofing membrane.
2. Unroll and position membrane without stretching.
3. Position sheets to accommodate contours of roof deck.
4. Apply bonding adhesive in accordance with manufacturer's instructions, to underside of membrane and substrate.
5. Roll coated membrane into coated substrate.
    a. Avoiding wrinkles.
6. Membrane splices:
    a. Comply with manufacturer’s instructions for splicing procedures.
    b. Locate field splices away from low areas and drain sumps.
    c. Shingle splices to avoid bucking water.
7. Membrane flashing:
    a. Flash penetrations and walls with cured EPDM membrane or flashing.
    b. Exceptions:
        1) Limit uncured flashings and pressure sensitive uncured flashing to overlaying of vertical seams, flashing of inside and outside corners, scuppers, and other unusually shaped penetrations.
        2) Utilize manufacturer’s standard pre-manufactured accessories.
    c. Terminate base-of-wall flashings in accordance with manufacturer’s approved details.
    d. Pre-flashing at sheet metal parapet copings:
        1) Extend EPDM membrane and/or flashing over top of parapet prior to capping with sheet metal.
    e. Expansion joints:
        1) Extend EPDM membrane across roofing expansion joints.
        2) Include adequate slack in membrane to accommodate anticipated movement.
8. Hot or cold weather procedures:
    a. Comply with manufacturer’s instructions.

G. Edge Metal and Coping:
1. Sub-flash details with a layer of EPDM membrane prior to installation of edge metal or coping system.
2. Secure anchor cleat to blocking as recommended, using corrosion-resistant fasteners.

3. Install splice plates and snap-on covers.

H. Walkways:

1. Install walkways at traffic concentration points, such as roof hatches, access doors, rooftop ladders, or locations as indicated.
2. Do not locate within 10 FT of roof edge.
3. Clean surfaces to be bonded.
4. Secure as recommended by membrane manufacturer.

I. Protection:

1. Seal system at end of work day to temporarily close membrane to prevent water infiltration.
2. Remove temporary water cutoffs prior to proceeding with Work.
3. Remove and replace wet insulation.

3.3 SCHEDULE OF ROOF SYSTEMS

A. Roof System 1 - Fully Adhered EPDM over Steel Deck:

1. Sheathing.
2. Vapor retarder.
3. Insulation.
4. Cover Board.
5. EPDM Membrane, adhered.

END OF SECTION

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SECTION 07 62 00 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Flashing and Sheet Metal, as indicated, in accordance with provisions of Contract Documents.

1.2 QUALITY ASSURANCE

A. ASTM International (ASTM):

1. ASTM A153/A153M Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
2. ASTM A653/A653M Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process
3. ASTM B209 Standard Specification for Aluminum-Alloy Sheet and Plate
4. ASTM B221 Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles and Tubes
5. ASTM B308/B308M Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles
6. ASTM F2329/F2329M Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners

B. Sheet Metal and Air Conditioning Contractors National Association (SMACNA):

1. Architectural Sheet Metal Manual

1.3 SUBMITTALS

A. Product Data:

1. For each type of material and accessory.

B. Shop Drawings:

1. Dimensioned drawings of profiles and shapes.
2. Plans and elevations to show locations of each shape.

C. Samples:

1. For finish, color and color range selection.

D. Contract Closeout Information:

1. Warranty

1.4 WARRANTY

A. Furnish 20 year finish warranty on PVDF coated sheet metal, <u>covering color, fade, chalking and film integrity.</u>

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Formed Sheet Metal:

1. Basis of Design:

a. Ryerson Metals, ColorKlad.

2. Optional:

a. Berridge Manufacturing Company.
b. Petersen Aluminum, PAC-CLAD.

B. Reglets:

1. Basis of Design:

a. Fry Reglet.

C. Other materials:

1. Base:

a. Manufacturers as noted.

2.2 MATERIALS

A. Sheet Metal – Galvanized Steel with PVDF coating.

1. ASTM A653/A653M galvanized steel, Z275 G90.
2. Minimum thickness: 0.024 IN 0.6 MM or as noted for individual fabrications.
3. Smooth
4. PVDF coating: Minimum 1 MIL 0.025 MM fluorocarbon coating, 70% PVDF.

2.3 SHEET METAL FABRICATIONS

A. Hanging Gutters:

1. Fabricate to size and profile indicated, complete with end pieces, outlet tubes, and other accessories as required.

a. Gutters shall be complete with mitered corners, end caps, and outlets sized to fit downspouts.

2. Material:

Hanging Gutters - Minimum Sheet Thickness / Weight				
Material	Gutter Girth			
	up to 20 IN up to 520 MM	**21 to 25 IN** 521 to 650 MM	**26 to 30 IN** 651 to 770 MM	**31 to 35 IN** 771 to 890 MM
PVDF coated Galvanized Steel	0.024 IN 0.61 MM	0.034 IN 0.864 MM	0.040 IN 1.016 MM	0.052 IN 1.132 MM
PVDF coated Galvanized Steel	0.040 IN 1.016 MM	0.050 IN 1.27 MM	0.063 IN 1.6 MM	-
PVDF coated Galvanized Steel	0.019 IN 0.483 MM	0.025 IN 0.635 MM	0.031 IN 0.787 MM	0.038 IN 0.965 MM

3. Fabricate sections in maximum lengths practical; not less than 96 IN 2440 MM long.
4. Furnish flat-stock gutter spacers and gutter brackets fabricated from same metal as gutters, of size recommended by SMACNA but not less than twice gutter thickness.
5. Fabricate expansion joints, expansion joint covers, gutter bead reinforcing bars, and gutter accessories from same metal as gutters.
6. Gutter supports shall be adjustable minimum 1 IN 25 MM wide by minimum 0.080 IN 2 MM thick hanger, provided in sufficient number to be located at maximum 30 IN 760 MM on center, or minimum 0.032 IN 0.81 MM thick continuous cleats.
7. Expansion Joints: Lap or Butt types.

B. Through Wall Parapet Scuppers:

1. Fabricate to dimensions indicated with closure flange trim to exterior, 4 IN 100 MM wide wall flanges to interior, and base extending 4 IN 100 MM beyond cant or tapered strip into field of roof.

C. Conductor Heads:

1. Fabricate conductor heads with flanged back and stiffened top edge and of dimensions and shapes indicated.
2. Include outlet tube and exterior flange trim.
3. Include built-in overflows where indicated.

2.4 ACCESSORIES

A. Fasteners:

1. Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by flashing manufacturer.
2. Blind fasteners or self-drilling screws, gasketed, with hex-washer head.
3. Exposed Fasteners: Heads matching color of sheet metal using plastic caps or factory-applied coating.
4. Blind Fasteners: High strength aluminum or stainless steel rivets suitable for metal being fastened.
5. Spikes and Ferrules: Same material as gutter; with spike with ferrule matching internal gutter width.
6. Fastener Materials:

    a. Fasteners for Galvanized Steel Sheet: Series 300 stainless steel or hot-dip galvanized steel according to ASTM A153/A153M or ASTM F2329/F2320M.

B. Cleats:

1. 16 GA 1.6 MM galvanized or stainless steel.

C. Dissimilar metal and cementitious materials protection:

1. Alkali resistant bituminous paint.
2. Tnemec TnemeTar 46-413.

D. Base Flashing:

1. Fabricate to size and profile indicated.

E. Counterflashing and Flashing Reglets:

1. Fabricate to size and profile indicated.
2. Provide interior and exterior preformed corners as required.
3. Fabricate as required to fit special conditions.

F. Sealants: Specified in Section 07 92 00.

2.5 FABRICATION

A. General:

1. Fabricate true and sharp to profiles and sizes indicated.
2. Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA Architectural Sheet Metal Manual, that apply to design, dimensions, geometry, metal thickness, and other characteristics of item indicated.
3. Shop fabricate items to greatest extent possible.
4. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
5. Form sheet metal flashing and trim without oil canning, buckling, and tool marks, true to line and level indicated, with exposed edges folded back to form hems.
6. Conceal fasteners and expansion provisions where possible. Exposed fasteners not allowed on faces exposed to view.

B. Fabrication Tolerances:

1. Fabricate sheet metal flashing and trim to tolerance of 1/4 IN per 20 FT 6 MM per 6 M on slope and location lines as indicated and within 1/8 IN 3 MM offset of adjoining faces and alignment of matching profiles.

C. Sealed Joints: Form movable joints in metal to accommodate elastomeric sealant.

D. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 IN 25 MM deep. Fill with butyl sealant concealed within joints.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Fabricate cleats and attachment devices of sizes as recommended by SMACNA Architectural Sheet Metal Manual for application, but not less than thickness of metal being secured.

G. Seams in metals with painted, coated or lacquered finishes:

1. Fabricate nonmoving seams with flat-lock seams.
2. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use.

H. Do not use graphite pencils to mark metal surfaces.

PART 3 - EXECUTION

3.1 INSPECTION AND PREPARATION

A. Verify suitability of substrates to accept work.

1. Verify continuous wood blocking sloped 1:12, and covered with one layer of building paper or roofing membrane.

B. Installation constitutes acceptance of conditions and responsibility for performance.

3.2 INSTALLATION - GENERAL

A. Install in accordance with details and recommendations of SMACNA, current edition.

B. Set shop fabricated interior and exterior preformed corners and intersections.

C. Set top edges of flashings into reglets as indicated.

D. Fasten materials at recommended intervals.

E. Provide slip joints to allow for thermal movement.

1. Use SMACNA Table 3-1, Design J9 - J12, with caulked lap.
2. Maximum spacing: 10 FT 3 M on center.
3. Provide slip joint in conjunction with splices and corners.

F. Caulk joints with 2 beads of sealant on each overlap: See Section 07 92 13.

G. Turn down cap flashing over base flashings 4 IN 100 MM and caulk.

H. Form flashings to provide spring action with exposed edges hemmed or folded.

I. Provide dissimilar metals and materials protection where dissimilar metals come in contact, or where sheet metal contacts mortar or concrete.

J. Provide miscellaneous sheet metal items not specifically covered elsewhere, as indicated or required to provide a weathertight installation.

3.3 INSTALLATION – GUTTERS AND DOWNSPOUTS

A. Install gutters below slope line of roof, supported on adjustable hangers spaced maximum 30 IN 760 MM on center or by continuous cleats.

B. Join gutter sections with flat locked, riveted and sealed joints with hard setting sealant fill.

C. Adjust gutters to slope uniformly to downspout outlets, with high point midway between outlets.

D. Install downspouts supported by leader straps or concealed rack and pin type fasteners at top, bottom and intermediate points not exceeding 5 FT 1.5 M on center.

E. Install downspout 1 IN clear of building wall.

3.4 CLEAN-UP

A. Upon completion of work, repair damaged areas.

B. Repair finish of PVDF coated flashing which fades or is damaged.

C. Clean stains and debris.

D. Remove protective coverings.

END OF SECTION

SECTION 07 84 13 - PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: through-penetration firestop systems for penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items including but not limited to.

1. Penetrations in fire resistance rated walls.
2. Penetrations in horizontal assemblies.
3. Penetrations in smoke barriers.

1.2 ACTION SUBMITTALS

A. Product Data: Product Data: Technical data for each penetrating firestopping system including illustration of firestopping system and design designation.

B. Product Schedule: Submit schedule for each penetration firestopping system indicating location, illustration of firestopping system, and design designation of qualified testing and inspecting agency.

1. Engineering Judgments: Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration firestopping system, submit illustration, with modifications marked, approved by penetration firestopping system manufacturer's fire protection engineer as an engineering judgment or equivalent fire resistance rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: Submit data for Installer.

B. Product Test Reports: Submit reports for each penetration firestopping system and for tests performed by a qualified testing agency.

C. Provide UL assembly information on each penetration indicating all materials.

1.4 CLOSEOUT SUBMITTALS

A. Installer Certificates: Submit certificates from Installer indicating that penetration firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.5 QUALITY ASSURANCE

A. Installation Responsibility: Assign installation of through-penetration firestop systems and fire-resistive joint systems in Project to a single qualified installer.

B. Installer Qualifications: Entity having minimum 5 years documented experience that has been approved by FM Global according to FM Global 4991 Approval of Firestop Contractors or evaluated by UL and found to comply with its Qualified Firestop Contractor Program Requirements and employs applicators with the required experience and training to perform the work.

1. Manufacturer's willingness to sell its penetrating firestopping system products to Contractor or to Installer does not confer qualification on buyer.
2. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements.

C. Preinstallation Conference: Conduct conference at site.

1.6 COORDINATION

A. Do not cover up through penetration firestop system installations that will become concealed behind other construction until each installation has been examined by Owner's inspecting agency and building inspector when required by authorities having jurisdiction.

1. Notify Owner's testing agency at least seven days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.

B. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.

C. Coordinate sizing of sleeves, openings, core drilled holes, or cut openings to accommodate penetration firestopping systems.

D. Notify Owner's testing agency at least seven days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.

B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced air circulation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: For penetrations through fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.

B. Fire Test Response Characteristics:

1. Perform penetration firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.
2. Test in accordance with referenced standards. Provide rated systems complying with the following requirements:

    a. Penetration firestopping systems shall bear classification marking of a qualified testing agency.

        1) UL Fire Resistance Directory.
        2) FM Global Building Materials Approval Guide.

C. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per ASTM E 814 or UL 1479:

1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
2. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas:

    a. Penetrations located outside wall cavities.
    b. Penetrations located outside fire-resistance-rated shaft enclosures.

3. L-Rated Systems: Where through-penetration firestop systems are indicated in smoke barriers, provide through-penetration firestop systems with L-ratings indicated at both ambient temperatures and 400 deg F (204 deg C).

D. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.

1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
2. For floor penetrations with annular spaces exceeding 4 inches (100 mm) in width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved, either by installing floor plates or by other means.

3. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.
4. Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

2.2 PENETRATION FIRESTOPPING SYSTEMS

A. Penetration Firestopping Systems: Provide Penetration Firestopping Systems that resist spread of fire, passage of smoke and gases, and maintain original fire resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. 3M Fire Protection Products.
    b. A/D Fire Protection Systems Inc.
    c. Hilti, Inc.
    d. Nelson Firestop Products, Division of EGS Electrical Group.
    e. Passive Fire Protection Partners.
    f. RectorSeal.
    g. Specified Technologies, Inc.

B. Penetrations in Fire Resistance Rated Walls: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa). Fire resistance rated walls include fire rated walls, fire barrier walls, smoke barrier walls and fire partitions.

1. F-Rating: Not less than the fire resistance rating of constructions penetrated.

C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).

1. F-Rating: At least one hour, but not less than the fire resistance rating of constructions penetrated.
2. T-Rating: At least one hour, but not less than the fire resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.

D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of 0.30 inch wg (74.7 Pa).

1. L-Rating: Not exceeding 5.0 cfm/sq. ft. (0.025 cu. m/s per sq. m) of penetration opening at and no more than 50-cfm (0.024-cu. m/s) cumulative total for any 100 sq. ft. (9.3 sq. m) at both ambient and elevated temperatures.

E. Exposed Penetration Firestopping Systems: Flame spread and smoke developed indexes of less than 25 and 450, respectively, per ASTM E 84.

F. Manufactured Piping Penetration Firestopping System: Penetration firestopping systems with ratings determined per ASTM E814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg (2.49 Pa).

1. Manufacturers: Subject to compliance with requirements, provide products by the following:

    a. ProVent Systems, Inc.

2. F-Rating: At least one hour, but not less than the fire resistance rating of constructions penetrated.
3. T-Rating: At least one hour, but not less than the fire resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
4. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.
5. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast in place concrete slabs.
6. Stack Fitting: ASTM A48/A48M, gray iron, hubless pattern wye branch with neoprene O ring at base and gray iron plug in thermal release harness. Include PVC protective cap for plug.
7. Special Coating: Corrosion resistant on interior of fittings.

G. Accessories: Provide components for each penetration firestopping system necessary to install fill materials and to maintain ratings required. Use components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.

1. Permanent forming/damming/backing materials.
2. Substrate primers.
3. Collars.
4. Steel sleeves.

2.3 [PENETRATION MOISTURE-STOPPING SYSTEMS

A. Penetration Moisture-stopping Systems: Systems that resist spread of fire, passage of smoke and gases, and maintain a weather tight moisture-seal for all items penetrating the exterior envelope and moisture sensitive conditions and spaces. Penetration moisture-stopping systems shall be compatible with one another, with substrates, formed openings, overall conditions of specific locations and with all penetrating items.

1. Basis of Design: Subject to compliance with requirements, provide the following:

    a. Roxtec Transit Systems by Roxtec Inc.

        1) Substitutions: Not permitted.

2. All assemblies shall meet the following general requirements:

    a. Rodent Resistant.
    b. Provide spare capacity for future needs where indicated.
    c. Maintain a tested watertightness of 4 Bar.
    d. Maintain a tested gas tightness of 2.5 bar.

B. Manufactured Assembly: Provide a complete manufactured designed assembly for penetrations grouped or single in applications for the exterior envelope and moisture sensitive conditions and spaces, meeting the following:

1. Frames: All frames of exterior envelope and moisture sensitive conditions shall be stainless steel meeting AISI 316. Provide frame extensions, sealing strips and gaskets, mold materials and other accessories for each application.

    a. Grouping: Frame sizes shall be of size 4, 6, 8, 10 or 12 and any combination thereof to meet the specific penetration requirements and to maintain a watertightness of 4 Bar and a gas tightness of 2.5 bar. All frames shall be paired with sealing modules and kits, anchors and all accessories.
    b. Provide Type SF frames for welding to structure.
    c. Provide Type GH for casting or bolted mounting conditions.
    d. All frames shall have an integral flange to facilitate sealing to meet water and gas tightness indicated.

2. Sealing Modules and Kits:

    a. Modules: Provide Roxtec RM sealing modules in either solid or multidiameter configurations applicable to the penetrations needed.
    b. Sealing Kits: Provide Roxtec compressible sealing kits as necessary to accommodate all penetrations and maintain a watertightness of 4 Bar and a gas tightness of 2.5 bar.

3. Module Compression Devices: Provide sealing module compression devices from the manufacturer specific to the frames utilized for each assembly sufficient to facilitate compression of the sealing modules and kits to meet and maintain a watertightness of 4 Bar and a gas tightness of 2.5 bar

C. Sealant Tape: High tack extruded synthetic rubber, non-curing sealant in tape form.

1. Basis-of-Design: 3m Weatherban Sealant Tape 5354.

D. Covers and Blank-off Plates: Provide 1/8-inch thick blank off plates of material to match frames with predrilled holes to conceal all exposed voids and components subject to damage.

E. Fasteners: Size and type matched to conditions and anchorage requirements; provide fasteners of Type 304 stainless steel.

F. Post Installed Anchors at Masonry or Concrete: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01, ICC-ES AC58, ICC-ES AC193 or ICC-ES AC308 as appropriate for the substrate.

1. Material: Stainless steel with bolts and nuts complying with ASTM F 593 and ASTM F 594, Alloy Group 1 or 2 (ASTM F 738M and ASTM F 836M, Grade A1 or A4).

2.4 FILL MATERIALS

A. Cast in Place Firestop Devices: Factory assembled devices for use in cast in place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex Sealants: Single component latex formulations that do not re-emulsify after cure during exposure to moisture. Provide water resistant materials for all floor penetrations.

C. Firestop Devices: Factory assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent Composite Sheets: Rigid panels consisting of aluminum foil faced intumescent elastomeric sheet bonded to galvanized steel sheet.

E. Intumescent Putties: Nonhardening, water resistant, intumescent putties containing no solvents or inorganic fibers.

F. Intumescent Wrap Strips: Single component intumescent elastomeric sheets with aluminum foil on one side.

G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.

H. Silicone Foams: Multicomponent, silicone based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

I. Silicone Sealants: Single component, silicone based, neutral curing elastomeric sealants.

J. Pre-installed Firestop Devices for Telecommunications and other cabling: Firestop devices designed to allow cables to penetrate fire-rated walls without the need for additional firestopping. Device shall include built-in firestop that will function through the range of 0% - partial – 100% visual cable fill. Device shall allow cables to be easily added or removed without the need to remove or reinstall firestopping materials.

1. Products: Subject to compliance with requirements, provide one of the following based on initial cable volume installed, plus 20 percent additional capacity:

a. Hitli Firestop Speed Sleeve (CP 653). Use in conjunction with CFS-SL GP Gang Plate where more than one device is required in the same partition or other application.
b. Hilti CFS-SL Series Firestop Gangplate – Utilize when existing cables require firestop device; select for specific installation requirements.
c. Specified Technologies Inc; EZ Path.

2.5 MIXING

A. Penetration Firestopping Materials: For products requiring mixing before application, comply with penetration firestopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the work.

B. Proceed with installation after correcting unsatisfactory conditions.

3.2 PREPARATION

A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.
2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form release agents from concrete.

B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Masking Tape: Use masking tape to prevent penetration firestopping from contacting adjoining surfaces that remain exposed on completion of the work and would otherwise be permanently stained or damaged by contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing firestopping's seal with substrates.

3.3 INSTALLATION

A. Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.

B. Install forming materials and other accessories of types required to support fill materials during application and in the position needed to produce cross sectional shapes and depths required to achieve fire ratings.

1. After installing fill materials and allowing to fully cure, remove combustible forming materials and accessories not forming permanent components of firestopping.

C. Install fill materials by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire resistance ratings.
2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.
4. Install firestop devices for telecommunications and other cabling in accordance with manufacturer’s tested assemblies and UL ratings. Follow all recommendations by the manufacturer for preparation, installation and rating to match that of surrounding construction.

3.4 IDENTIFICATION

A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches (76 mm) high and with minimum 0.375 inch (9.5 mm) strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet (4.57 m) from end of wall and at intervals not exceeding 30 feet (9.14 m).

B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self adhering type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing and inspecting agency.
4. Date of installation.
5. Manufacturer's name.
6. Manufacturer’s product and UL assembly number.
7. Installer's name.

3.5 FIELD QUALITY CONTROL

A. Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E 2174.

B. Where deficiencies are found or penetration firestopping system is damaged or removed because of testing, repair or replace penetration firestopping system to comply with requirements at no additional cost to Project.

C. Proceed with enclosing penetration firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.6 CLEANING AND PROTECTION

A. Clean off excess fill materials adjacent to openings as the work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite protections, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

END OF SECTION

SECTION 07 84 43 - JOINT FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Joints in or between fire resistance rated constructions.
2. Joints at exterior curtain wall/floor intersections.
3. Joints in smoke barriers.

1.2 ACTION SUBMITTALS

A. Product Data: Technical data for each joint firestopping system including illustration of firestopping system and design designation.

B. Product Schedule: Submit schedule for each joint firestopping system including location, illustration of firestopping system, and design designation of qualified testing agency.

1. Provide UL rated Design Assembly sheets for all assemblies intended to be included in the Project. Each assembly shall clearly indicate Design Number, Fire Rating expressed in number of hours and show all materials relative to the certification. Provide reference plans or other drawings indicating the location and intent of the designs submitted.
2. Engineering Judgments: Where Project conditions require modification to a qualified testing agency's illustration for a particular joint firestopping system condition, submit illustration, with modifications marked, approved by joint firestopping system manufacturer's fire protection engineer as an engineering judgment or equivalent fire resistance rated assembly.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: Submit data for Installer.

B. Product Test Reports: Submit reports for each joint firestopping system, for tests performed by a qualified testing agency.

1.4 CLOSEOUT SUBMITTALS

A. Installer Certificates: Submit certificates from Installer indicating that joint firestopping systems have been installed in compliance with requirements and manufacturer's written instructions.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Entity having minimum 5 years documented experience that has been approved by FM Global according to FM Global 4991 Approval of Firestop

Contractors or evaluated by UL and found to comply with its Qualified Firestop Contractor Program Requirements and employs applicators with the required experience and training to perform the work.

1. Manufacturer's willingness to sell its fire resistive joint system products to Contractor or to Installer does not confer qualification on buyer.

B. Preinstallation Conference: Conduct conference at site.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not install joint firestopping systems when ambient or substrate temperatures are outside limits permitted by joint firestopping system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.

B. Install and cure joint firestopping systems per manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced air circulation.

1.7 COORDINATION

A. The Contractor shall coordinate all Joint Firestopping assembly requirements and specific UL assemblies prior to Bid. Provide all UL assemblies as listed on the Drawings and as required to maintain all fire ratings pertaining to the Project in its entirety.

1. All questions and clarifications shall be posed to the Design Professional by the Contractor prior to Bid and without assumption.

B. Do not cover up joint firestopping system installations that become concealed behind construction until each installation has been examined by Owner's inspecting agency and building inspector when required by authorities having jurisdiction.

1. Notify Owner's testing agency at least seven days in advance of penetration firestopping installations; confirm dates and times on day preceding each series of installations.

C. Coordinate construction of joints to ensure that joint firestopping systems can be installed according to specified firestopping system design.

D. Coordinate sizing of joints to accommodate joint firestopping systems.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire Test Response Characteristics:

1. Perform joint firestopping system tests by a qualified testing agency acceptable to authorities having jurisdiction.

2. Test in accordance with testing in referenced standards. Provide rated systems complying with requirements:

    a. Joint firestopping systems shall bear classification marking of a qualified testing agency.

        1) UL Fire Resistance Directory.
        2) Intertek Group Directory of Listed Building Products.

2.2 JOINT FIRESTOPPING SYSTEMS

A. Joint Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire resistance rating of assemblies in or between which joint firestopping systems are installed. Joint firestopping systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases. All joints shall have a UL Rating unless noted otherwise.

B. Joints in or between Fire Resistance Rated Construction: Provide joint firestopping systems with ratings determined per ASTM E 1966 or UL 2079.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. 3M Fire Protection Products.
    b. A/D Fire Protection Systems Inc.
    c. Blazeframe Industries.
    d. CEMCO.
    e. Grabber Construction Products.
    f. Hilti, Inc.
    g. Nelson Firestop; a brand of Emerson Industrial Automation.
    h. NUCO Inc.
    i. Passive Fire Protection Partners.
    j. RectorSeal.
    k. ROXUL.
    l. Safti-Seal
    m. Specified Technologies, Inc.
    n. Thermafiber, Inc.; an Owens Corning company.

2. Fire Resistance Rating: Equal to or exceeding the fire resistance rating of the wall, floor, or roof in or between which it is installed.
3. Location: Joints include those installed in or between fire resistance rated walls floor or floor/ceiling assemblies and roofs or roof/ceiling assemblies.

C. Joints at Exterior Curtain Wall/Floor Intersections: Provide joint firestopping systems with rating determined per ASTM E 2307.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. 3M Fire Protection Products.

b. Hilti, Inc.
c. Nelson Firestop; a brand of Emerson Industrial Automation.
d. NUCO Inc.
e. RectorSeal.
f. Rockwool/Roxul.
g. Specified Technologies, Inc.
h. Thermafiber, Inc.; an Owens Corning company.

2. F-Rating: Equal to or exceeding the fire resistance rating of the floor assembly.

A. Perimeter Fire Containment Systems at Exterior Wall / Floor Intersections: Provide a current UL Rated joint firestopping systems with rating determined per ASTM E 2307.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. 3M Fire Protection Products.
b. Hilti, Inc.
c. Nelson Firestop; a brand of Emerson Industrial Automation.
d. NUCO Inc.
e. RectorSeal.
f. Rockwool/Roxul.
g. Specified Technologies, Inc.
h. Thermafiber, Inc.; an Owens Corning company.

2. F-Rating: Equal to or exceeding the fire resistance rating of the floor assembly.
3. General:

a. Provide compatible perimeter fire containment system products, forming material, fillers, sealants and other items, to substrates forming openings, under conditions of service and application.
b. Provide components for each perimeter fire containment system needed to install fill materials.
c. Utilize products tested for specific fire-resistance-rated construction to non-rated construction conditions conforming to construction assembly type, linear void width, and fire-rating involved for each separate instance.

4. Silicone Sealants:

a. One part non-sag or self-leveling silicone elastomeric firestopping sealant.
b. Latex sealant not permitted for Fire Containment Systems at Exterior Wall / Floor Intersections.

5. Mineral Wool Insulation:

a. Faced or unfaced batts or blankets used for exterior walls with the capacity to contribute to fire-resistance of assembly.
b. Approved component of the UL-system proposed.

6. Safing Insulation:

a. Board or sheet products used as forming materials in edge of slab openings with capacity to provide a degree of fire resistance required when used with approved fill material.

7. Closure Plates: Provide closure plates as indicated and required for the UL rated assemblies indicated for perimeter fire containment systems at exterior wall / floor intersections.
8. Provide UL classified systems referred to system numbers in UL Fire Resistance Directory under product Category XHDG or Category XHBN.

B. Joints in Smoke Barriers: Provide fire resistive joint systems with ratings determined per UL 2079 based on testing at a positive pressure differential of 0.30-inch wg (74.7 Pa).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. 3M Fire Protection Products.
b. A/D Fire Protection Systems Inc.
c. Hilti, Inc.
d. Nelson Firestop; a brand of Emerson Industrial Automation.
e. NUCO Inc.
f. Passive Fire Protection Partners.
g. RectorSeal.
h. Rockwool/Roxul.
i. Specified Technologies, Inc.
j. Thermafiber, Inc.; an Owens Corning company.

2. L-Rating: Not exceeding 5.0 cfm/ft. (0.00775 cu. m/s x m) of joint at both ambient and elevated temperatures.

C. Exposed Joint Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

D. Accessories: Provide components of fire resistive joint systems, including primers and forming materials, necessary to install elastomeric fill materials and to maintain ratings required. Use components specified by joint firestopping system manufacturer and approved by the qualified testing agency for conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for joint configurations, substrates, and other conditions affecting performance of the work.

B. Proceed with installation after correcting unsatisfactory conditions.

3.2 PREPARATION

A. Surface Cleaning: Before installing fire resistive joint systems, clean joints immediately to comply with fire resistive joint system manufacturer's written instructions and the following requirements:

1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of elastomeric fill materials or compromise fire resistive rating.
2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with elastomeric fill materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form release agents from concrete.

B. Prime substrates where recommended in writing by joint firestopping system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

C. Protection: Use masking tape or other protection method to prevent materials of fire-resistive joint system from contacting adjoining surfaces that will remain exposed on completion of the Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove stains. Remove tape as soon as possible without disturbing fire-resistive joint system's seal with substrates.

3.3 INSTALLATION

A. Install fire resistive joint systems to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support elastomeric fill materials during application and in position needed to produce cross sectional shapes and depths required to achieve fire ratings indicated.

1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire resistive joint system.

C. Install elastomeric fill materials for fire resistive joint systems by proven techniques to produce the following results:

1. Elastomeric fill voids and cavities formed by joints and forming materials as required to achieve fire resistance ratings indicated.
2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
3. For elastomeric fill materials that will remain exposed after completing the work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.
4. Install firestop devices for telecommunications and other cabling in accordance with manufacturer’s tested assemblies and UL ratings. Follow all recommendations by the manufacturer for preparation, installation and rating to match that of surrounding construction.

3.4 IDENTIFICATION

A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches (76 mm) high and with minimum 0.375 inch (9.5 mm) strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet (4.57 m) from end of wall and at intervals not exceeding 30 feet (9.14 m).

B. Joint Identification: Identify joint firestopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches (150 mm) of joint edge so labels are visible to anyone seeking to remove or joint firestopping system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Joint Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address, and phone number.
3. Designation of applicable testing agency.
4. Date of installation.
5. Manufacturer's name.
6. Manufacturer’s product and UL assembly number.
7. Installer's name.

C. Inspecting Agency: Owner will engage a qualified testing agency to perform tests and inspections according to ASTM E 2393.

D. Where deficiencies are found or joint firestopping systems are damaged or removed due to testing, repair or replace joint firestopping systems so they comply with requirements.

E. Proceed with enclosing joint firestopping systems with other construction only after inspection reports are issued and installations comply with requirements.

3.5 CLEANING AND PROTECTION

A. Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by joint firestopping system manufacturers and that do not damage materials in which joints occur.

B. Provide final protection and maintain conditions during and after installation that ensure joint firestopping systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire resistive joint systems immediately and install new materials to produce fire resistive joint systems complying with specified requirements.

3.6 FIRE RESISTIVE JOINT SYSTEM SCHEDULE

A. Provide all Joint Firestopping System Assemblies as indicated on the Drawings and as required to maintain all fire ratings of assemblies throughout the Project.

B. Where UL classified systems are indicated, they refer to system numbers in UL Fire Resistance Directory under product Category XHBN or Category XHDG.

C. Where Intertek ETL SEMKO listed systems are indicated, they refer to design numbers in Intertek ETL SEMKO's "Directory of Listed Building Products" under product category Expansion/Seismic Joints or Firestop Systems.

END OF SECTION

SECTION 07 92 00 - JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Preparation of interior and exterior joint substrate surfaces.
2. Install sealers, primers, bond breakers, and fillers as required.
3. Install interior and exterior joint sealants.

1.2 REFERENCES

A. American Society for Testing and Materials:

1. ASTM C 834: Specification for Latex Sealants.
2. ASTM C 920: Specification for Elastomeric Joint Sealants.
3. ASTM C 1087: Test Method for Determining Compatibility of Liquid Applied Sealants with Accessories Used in Structural Glazing Systems.
4. ASTM C 1193: Guide for Use of Joint Sealants.
5. ASTM C 1311: Specification for Solvent Release Sealants.
6. ASTM C 1330: Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.
7. ASTM C 1521: Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints.

1.3 SYSTEM DESCRIPTION

A. Design Requirements:

1. Exterior: Provide elastomeric joint sealants that have been produced and installed to establish and to maintain watertight and air tight continuous seals without causing staining or deterioration of joint substrates.
2. Interior: Provide joint sealants that have been produced and installed to maintain airtight continuous seals that are water resistant and cause no staining or deterioration of joint substrates.

1.4 ACTION SUBMITTALS

A. Product Data: Submit manufacturer's product data, specifications, recommendations and instructions for surface preparation, sealant and backing installation, and related materials.

B. Samples: Submit standard color charts for selection; furnish samples of custom colors as applicable.

C. Joint-Sealant Schedule: Include the following information, using same “Type” designations indicated in Specifications:

1. Joint-sealant application and substrate.
2. Joint-sealant manufacturer and product name.
3. Joint-sealant formulation.

1.5 INFORMATIONAL SUBMITTALS

A. Preconstruction Compatibility and Adhesion Test Reports: From sealant manufacturer, indicating the following:

1. Materials forming each joint substrate and joint-sealant backings have been tested for compatibility and adhesion with each joint sealant.
2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

B. Field-Adhesion-Test Reports: For each sealant application tested.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Provide documentation of minimum three years experience approved by sealant manufacturer.

B. Pre-Installation Meeting: Prior to installation of sealant, meet at project site to review material selections, joint preparations, installation procedures and coordination with other trades. Meeting shall include the sealant Installer, Contractor, Manufacturer's representative, and representatives of other trades or subcontractors affected by sealant installation. Examine sample installations which have been prepared and determine and record whether everyone present is in agreement that the proposed installations are likely to perform as required. Notify Architect prior to meeting as to time, place and date of meeting.

1.7 PRECONSTRUCTION TESTING

A. Preconstruction Compatibility and Adhesion Testing: Submit to joint-sealant manufacturers, for testing indicated below, samples of materials that will contact or affect joint sealants.

1. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of joint sealants to joint substrates.
2. Submit not fewer than four pieces of each kind of material, including joint substrates, shims, joint-sealant backings, secondary seals, and miscellaneous materials.
3. Schedule sufficient time for testing and analyzing results to prevent delaying the Work.
4. For materials failing tests, obtain joint-sealant manufacturer's written instructions for corrective measures including use of specially formulated primers.

5. Testing will not be required if joint-sealant manufacturers submit joint preparation data that are based on previous testing, not older than 24 months, of sealant products for adhesion to, and compatibility with, joint substrates and other materials matching, identically, those submitted.

1.8 DELIVERY STORAGE, AND HANDLING

A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multicomponent materials.

B. Store and handle materials in compliance with manufacturer's recommendation to prevent their deterioration or damage due to moisture, high or low temperatures, contaminates, or other causes.

1.9 PROJECT CONDITIONS

A. Environmental Conditions: Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate conditions are outside limits permitted by joint sealant manufacturer or below 40 deg. F.
2. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
3. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.
4. When joint substrates are wet.

1.10 WARRANTY

A. Exterior Sealants:

1. Special Installer's Warranty: Manufacturer's standard form in which Installer agrees to repair or replace joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.

    a. Warranty Period: Five years from date of Substantial Completion.

2. Special Manufacturer's Warranty for Silicone Sealants: Manufacturer's standard form in which joint-sealant manufacturer agrees to furnish joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.

    a. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - - PRODUCTS

2.1 MANUFACTURERS

A. Substitutions: Comply with Division 01.

2.2 SEALING AND CAULKING MATERIALS

A. Polyurethane Sealant - Type No. 1:

1. One-component, non-sag, low modulus, moisture curing, polyurethane joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT, M, A, and O.
2. Acceptable Products:

    a. Dymonic 100 by Tremco.
    b. MasterSeal NP 100 by Sika.
    c. Dynatrol I-XL by Pecora.
    d. Sikaflex 15LM by Sika.

B. Polyurethane Sealant - Type No. 2:

1. Multi-component, non-sag, low-modulus, chemically curing, modified polyurethane joint sealant; ASTM C 920, Type M, Grade NS, Class 25, Use NT, M, A, and O.
2. Acceptable Products:

    a. MasterSeal NP 2 by Sika. 25
    b. Dynatrol II by Pecora. 50
    c. Sikaflex 2cNS EZ Mix by Sika. 50

C. Polyurethane Sealant - Type No. 3:

1. One-component, low-modulus, moisture curing, cold applied, elastomeric, self-leveling, pourable, horizontal grade polyurethane joint sealant; ASTM C 920, Type S, Grade P, Class 25, Use T, M.
2. Acceptable Products:

    a. Vulkem 45SSL by Tremco.
    b. Sikaflex 1c SL by Sika.
    c. MasterSeal SL 1 by Sika.
    d. Urexpan NR-201 by Pecora.

D. Polyurethane Sealant Type - Type No. 4:

1. Multi-component, non-sag, chemically curing, cold applied, elastomeric, traffic grade, polyurethane joint sealant exceeding 1 percent slope; ASTM C 920, Type M, Grade P, Class 25, Use T.
2. Acceptable Products:

    a. MasterSeal SL 2 by Sika.
    b. Vulkem 445SSL by Tremco.

c. DynaTrol II-SG by Pecora.
d. Sikaflex 2c NS TG by Sika.

E. Polyurethane Sealant - Type No. 5:

1. Two-component, chemically curing, cold applied, elastomeric, horizontal grade, self-leveling, fuel resistant polyurethane joint sealant; ASTM C 920, Type M, Grade P, Class 25, Use T.
2. Acceptable Products:

a. MasterSeal CR 125 by Sika.
b. Urexpan NR-200 by Pecora.
c. Sikaflex 2c SL by Sika.

F. Polyurethane Sealant - Type No. 6:

1. One-component, moisture curing, non-sag, polyurethane joint sealants, suitable for continuous immersion in water; ASTM C920, Type S, Grade NS, Class 25/50, Use NT, M, A, O and I.
2. Acceptable Product:

a. Vulkem 116 by Tremco.
b. MasterSeal NP 1 by Sika.

G. Acrylic Latex Sealant - Type No. 7:

1. One-component, fungicidal, readily paintable acrylic latex calk; ASTM C 834.
2. Acceptable Products:

a. Tremflex 834 Acrylic Latex by Tremco.
b. NP 520 by Sika.
c. AC-20 + Silicone by Pecora.
d. RCS20 by General Electric Sealants.

H. Silicone Sealant - Type No. 8:

1. One-component, moisture cured, non-staining, silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT, G, M, A, and O.
2. Acceptable Products:

a. DOWSIL 756 SM by Dow Corning 50.
b. Silpruf SCS9000 NB by GE Momentive.
c. Spectrem 3 and Spectrem 4-TS by Tremco.
d. 864 NST by Pecora.
e. Sikasil WS-295 by Sika.

I. Silicone Sealant Type - No. 9:

1. One-component, low-modulus, moisture cured, elastomeric, silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 100/50, Use NT, A, G, M, and O.

2. Acceptable Products:

    a. DOWSIL 790 by Dow Corning.
    b. Silpruf SCS2700 LM by GE Momentive.
    c. Spectrem-1 by Tremco.
    d. 890NST or 890FST by Pecora.
    e. Sikasil WS-290 by Sika.

J. Silicone Sealant - Type No. 10:

1. One-component, medium modulus, moisture cured, elastomeric silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT, A, G, M and O.
2. Acceptable Products:

    a. DOWSIL 795 by Dow Corning.
    b. Silpruf SCS2000 by GE Momentive.
    c. Spectrem 2 or Spectrem 3 by Tremco.
    d. 895NST by Pecora.
    e. Sikasil WS-295 by Sika.

K. Silicone Sealant - Type No. 11:

1. One-component, moisture cured, fungicidal, silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT, A, G, and O.
2. Acceptable Products:

    a. DOWSIL 786 by Dow Corning.
    b. SCS1700 by GE Momentive.
    c. TremSil 200 by Tremco.
    d. 898NST by Pecora.
    e. Sikasil GP by Sika.

L. Polysulfide Sealant - Type No. 12:

1. Multi-component, chemically cured, polysulfide joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use T, G, M, A, and O.
2. Acceptable Products:

    a. Synthacalk GC 2+ by Pecora.
    b. Deck-O-Seal One Step by W. R. Meadows, Inc.

M. Butyl - Type No. 13:

1. Butyl rubber polymer sealant one-component, non-sag; ASTM C 1311(FS TT-S-001657).
2. Acceptable Products:

    a. BC-158 by Pecora.
    b. Butakauk by Sika.

N. Silyl-Terminated Polyether (STPE) Sealant - Type No. 14:

1. Single-component, low-modulus, moisture cured, elastomeric, silyl-terminated polyether joint sealant; ASTM C 920, Type S, Grade NS, Class 50, Use NT, A, G, M and O.
2. Acceptable Products:

    a. SCS7000 by GE Momentive.
    b. DynaTrol I-XL Tru-White by Pecora Corporation.
    c. MasterSeal NP 150 by Sika.

O. Silicone Sealant - Type No. 15:

1. Single-component, moisture cured, silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 25, Use NT, A, G, M and O.
2. Acceptable Products:

    a. DOWSIL 758 by Dow Corning
    b. Elemax 5000 Liquid Flashing by GE Momentive.

2.3 ACCESSORIES

A. Joint Cleaner: Non-corrosive type recommended by sealant manufacturer, compatible with joint forming materials.

B. Primer: Non-staining type recommended by sealant manufacturer to suit application and substrate materials.

C. Backer Rod:

1. ASTM C 1330, Type C (closed-cell material with a surface skin), or Type B (bicellular material with a surface skin), as approved in writing by joint-sealant manufacturer for joint application indicated, and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
2. Acceptable Products:

    a. Backer Rod Manufacturing; Mile High Foam.
    b. Sika; Soft Backer Rod.
    c. Nomaco; Sof Rod.
    d. Ethafoam SB, Dow Chemical.

D. Precompressed Joint Sealer:

1. Precompressed bitumen impregnated foam; when exposed to air expands in size; size as recommended by manufacturer for joint condition and width; black color.
2. Acceptable Products:

    a. Backerseal by Emseal Corporation.
    b. 600 by Will-Seal.

E. Bond Breaker: Pressure sensitive adhesive polyethylene tape recommended by sealant manufacturer to suit application.

F. Masking Tape: Pressure sensitive adhesive paper tape.

G. Sealant Tape:

1. Compressible adhesive-cohesive tape of cross-linked butyl polyisobutylene rubber that accommodates variations and movement, sized as necessary to allow for joint movement of ± 25 percent.
2. Acceptable Products:

a. 440 by Tremco.
b. Extru-Seal by Pecora.
c. PTI-606 by Protective Treatments, Inc., Division of Prosoco

H. Expansion Joint Filler:

1. Closed cell polyethylene compatible with sealant.
2. Asphalt impregnated fiberboard not acceptable.
3. Acceptable Product: Sonofoam Closed Cell Backer-Rod by Sonneborn.

2.4 MIXING

A. Mix components in accordance with manufacturer's recommendations.

PART 3 - - EXECUTION

3.1 EXAMINATION

A. Examine joints to be sealed for construction defects which could adversely affect execution of Work.

B. Ensure that concrete has cured 28 days minimum before commencing sealing operations.

C. Compressible Fillers: Verify actual width of each type joint to be sealed against indicated joint width to ensure compliance with specified percentage of compression required.

D. Determine in conjunction with sealant manufacturer's representative if adhesion testing is necessary prior to application of materials. Submit letter of certification from sealant manufacturer accepting substrate conditions for sealant.

3.2 PREPARATION

A. Clean joint surfaces using joint cleaner as necessary, free of dust, dirt, oil, grease, rust, lacquers, laitance, release agents, liquid water repellent, moisture or other matter which

might adversely affect adhesion of sealants. Immediately after cleaning, wipe all joint surfaces with a clean dry cloth to remove any cleaner residue.

B. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air.

C. Etch concrete, masonry and plaster joint surfaces to remove excess alkalinity. Etch with 5 percent solution of muriatic acid. Neutralize with dilute ammonia solution. Rinse thoroughly with water and allow to dry.

D. Steel Surfaces: Scrape and wire brush to remove loose mill scale. Remove dirt, oil or grease by solvent cleaning. Wipe surfaces with lintless paper towels.

E. Aluminum Surfaces:

1. Clean off temporary protective coatings.
2. When masking tape is used for a protective cover, remove tape just prior to applying sealant.

F. Roughen joint surfaces on non-porous materials. Rub with fine abrasive cloth or wool to produce a dull sheen.

G. Mask areas adjacent to joints as necessary.

H. Apply primer as recommended by manufacturer. Do not allow primer or sealants to spill or migrate onto adjoining surfaces.

3.3 APPLICATION

A. Install sealant materials in accordance with manufacturer's instructions.

B. Install backing material in joints using blunt instrument to avoid puncturing.

C. Install sealant backing to form joint depth of 50 percent of joint width, minimum of 1/4" deep.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture, or tear sealant backings.
3. Do not braid smaller diameter sealant backings to create larger ones.
4. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

D. Apply sealant in joints using pressure gun with nozzle cut to fit joint width.

E. Deposit sealant in uniform, continuous bead.

F. Tool joints to required configuration within manufacturer's recommended setting time.

G. If masking materials are used, remove immediately after tooling.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Representative:

1. No sealants may be used unless a qualified representative is present at start up of work to advised installer of proper procedures and precautions for use of materials and to check installation.
2. Contractor shall give manufacturer notice one week prior to start-up that his presence will be required, to ensure proper installation of his materials.

B. Field-Adhesion Testing: Engage a qualified testing agency to field test joint-sealant adhesion to joint substrates as follows:

1. Extent of Testing: Test completed and cured sealant joints as follows:

   a. Perform five tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.
   b. Perform 1 test for each 1000 feet of joint length thereafter.

2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.

   a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.

3. Inspect tested joints and report on the following:

   a. Whether sealants filled joint cavities and are free of voids.
   b. Whether sealant dimensions and configurations comply with specified requirements.
   c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.

4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.

C. Evaluation of Field-Adhesion Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered

satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

A. Remove excess materials adjacent to joints as Work progresses to eliminate evidence of spillage or damage to adjacent surfaces.

B. Remove and replace improperly sealed joints.

C. Clean or replace materials or surfaces that are damaged by sealing operations.

3.6 SCHEDULE OF SEALANTS AND CAULKS

A. All sealants to be used on or in contact with the roofing system shall be recommended for use by the roofing system manufacturer or directly approved for use in the scope of Section 07 54 00 "Thermoplastic Membrane Roofing."

B. Unless indicated otherwise, all exterior building joints subject to dynamic movement, not exposed to foot or vehicular traffic: Sealant Type No. 9.

C. Stone, masonry, EIFS, architectural precast concrete, and metal panel substrates, for non-staining and low dirt pick-up applications subject to moisture, movement, and not exposed to foot or vehicular traffic: Sealant Type No. 8.

D. Interior building joints subject to dynamic movement, not exposed to foot or vehicular traffic: Sealant Type No. or 2.

E. Interior and exterior horizontal joints subject to foot and vehicular traffic: Sealant Type No. 3 or 4.

F. Unexposed Windows Joints: Sealant Type No. 10 or 12.

G. Interior horizontal and vertical joints not subject to movement or traffic, subject to moisture: Sealant Type No. 7 or 11.

H. Thresholds – Exterior: Sealant Type 12 or 13.

I. Underwater sealants in continuous immersion sealant: Sealant Type 6.

J. Exterior building joints subject to dynamic movement, not exposed to foot or vehicular traffic, which must be painted to match adjacent wall surfaces after installation: Sealant Type No. 14.

K. Exterior building joints in direct contact with air barrier materials: Sealant Type No. 15.

3.7 COLOR SCHEDULE

A. Curtain Wall and Storefronts: Custom color as selected by Architect.

B. Other Exposed Locations: Manufacturer's standard color line as selected by Architect.

C. Non-exposed Locations: Manufacturer's standard.

END OF SECTION

SECTION 08 36 00 - SECTIONAL OVERHEAD DOORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Glazed Aluminum Sectional Overhead Doors

B. Electric Operators and Controls.

C. Operating Hardware, tracks, and support.

1.2 REFERENCES

A. ANSI/DASMA 102 - American National Standard Specifications for Sectional Overhead Type Doors.

1.3 DESIGN / PERFORMANCE REQUIREMENTS

A. Wind Loads: Design and size components to withstand loads caused by pressure and suction of wind acting normal to plane of wall as calculated in accordance with applicable code.

B. Wiring Connections: Requirements for electrical characteristics.

1. 208 volts, single phase, 60 Hz (190-207V range)
2. 208 volts, three phase, 60 Hz (190-207V range)
3. 230 volts, single phase, 60 Hz (208-245V range)
4. 230 volts, three phase, 60 Hz (208-245V range)
5. 460 volts, three phase, 60 Hz (456-495V range)
6. 575 volts, three phase, 60 Hz (517-632V range)

C. Single-Source Responsibility: Provide doors, tracks, motors, and accessories from one manufacturer for each type of door. Provide secondary components from source acceptable to manufacturer of primary components.

D. Vehicle Bay Doors shall comply with U.S. Department of Transportation FAA Advisory 150/5210-15A.

1.4 SUBMITTALS

A. Submit under provisions of Division 01.

B. Product Data: Manufacturer's data sheets on each product to be used, including:

1. Preparation instructions and recommendations.
2. Storage and handling requirements and recommendations.
3. Installation methods.

C. Shop Drawings: Indicate plans and elevations including opening dimensions and required tolerances, connection details, anchorage spacing, hardware locations, and installation details.

D. Manufacturer's Certificates: Certify products meet or exceed specified requirements.

E. Operation and Maintenance Data.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with minimum five years documented experience.

B. Installer Qualifications: Authorized representative of the manufacturer with minimum five years documented experience.

C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories, Inc. acceptable to authority having jurisdiction as suitable for purpose specified.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened labeled packaging until ready for installation.

B. Protect materials from exposure to moisture until ready for installation.

C. Store materials in a dry, ventilated weathertight location.

1.7 PROJECT CONDITIONS

A. Pre-Installation Conference: Convene a pre-installation conference just prior to commencement of field operations, to establish procedures to maintain optimum working conditions and to coordinate this work with related and adjacent work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer: Overhead Door Corp., 2501 S. State Hwy. 121, Suite 200, Lewisville, TX 75067. ASD. Tel. Toll Free: (800) 275-3290. Phone: (469) 549-7100. Fax: (972) 906-1499. Web Site: www.overheaddoor.com. E-mail: sales@overheaddoor.com.

2.2 GLAZED ALUMINUM SECTIONAL OVERHEAD DOORS

A. Glazed Sectional Overhead Doors: 521 Series Aluminum Doors by Overhead Door Corporation.

1. Door Assembly: Stile and rail assembly secured with 1/4 inch (6 mm) diameter through rods.

a. Panel Thickness: 1-3/4 inches (44 mm).
b. Center Stile Width: 2-11/16 inches (68 mm)
c. End Stile Width: 3-5/16 inches (84 mm) - 2 Per End
d. Intermediate Rail Pair Width: 3-11/16 inches (94 mm).
e. Top Rail Width:

1) 2-3/8 inches (60 mm).
2) 3-3/4 inches (95 mm).

f. Bottom Rail Width:

1) 3-3/4 inches (95 mm).
2) 4-1/2 inches (114 mm).

g. Aluminum Panels: 0.050 inch (1.3 mm) thick, aluminum.
h. Stiles and Rails: 6063 - T6 aluminum.
i. Glazing:

1) 1/2 inch (12.5 mm) Tempered Insulating glass.

2. Finish and Color:

a. Powder Coating Finish: Color as selected by Architect from manufacturer's standard colors.

3. Windload Design: Provide to meet the Design/Performance requirements specified.
4. Hardware: Galvanized steel hinges and fixtures. Precision bearing rollers with hardened steel races.
5. Lock:

a. None
b. Interior galvanized single unit with interlock.

6. Weatherstripping:

a. Flexible bulb-type strip at bottom section.
b. Flexible Jamb seals.
c. Flexible Header seal.

7. Track: Provide track as recommended by manufacturer to suit loading required and clearances available.
8. Motor: Direct drive, integrated gear motor/brake assembly sized for openings. Provide with a manual hand chain for operation during power outages. Operator and drive assembly is provided with all wiring harnesses needed direct from the factory

a. Entrapment Protection: Required for momentary contact or,radio control operation.

1) Wireless electric sensing edge monitored to meet UL 325/2010.
2) Wired electric sensing edge monitored to meet UL 325/2010.
3) Photoelectric sensors that cast an invisible beam across the door opening and reverses the downward motion of the door when an object enters the path of the beam.
4) Built-in (to motor assembly) brake mechanism eliminates uncontrolled curtain travel independent of other safeties.

b. Maximum time to fully open any vehicle bay door is 16 seconds, or approximately 1 foot (0.3 M) per second.
c. Operator Controls:

1) Push-button operated control stations with open, close, and stop buttons.

2) Key operated control stations with open, close, and stop buttons.
3) Push-button and key operated control stations with open, close, and stop buttons.
4) Flush mounting.
5) Surface mounting.
6) Interior location.
7) Exterior location.
8) Both interior and exterior location.
9) One Open/Close/Stop push button station incorporated into Control Panel.
10) Radio control.
11) Loop detectors
12) Motion detectors.

d. Special Operation:

1) Pull switch.
2) Vehicle detector operation.
3) Radio control operation.
4) Card reader control.
5) Photocell operation.
6) Door timer operation.
7) Commercial light package.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin installation until openings have been properly prepared.

B. Verify wall openings are ready to receive work and opening dimensions and tolerances are within specified limits.

C. Verify electric power is available and of correct characteristics.

D. If preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.

B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install overhead doors and track in accordance with approved shop drawings and the manufacturer’s printed instructions.

B. Coordinate installation with adjacent work to ensure proper clearances and allow for maintenance.

C. Anchor assembly to wall construction and building framing without distortion or stress.

D. Securely brace door tracks suspended from structure. Secure tracks to structural members only.

E. Fit and align door assembly including hardware.

F. Coordinate installation of electrical service. Complete power and control wiring from disconnect to unit components.

3.4 CLEANING AND ADJUSTING

A. Adjust door assembly to smooth operation and in full contact with weatherstripping.

B. Clean doors, frames and glass.

C. Remove temporary labels and visible markings.

3.5 PROTECTION

A. Do not permit construction traffic through overhead door openings after adjustment and cleaning.

B. Protect installed products until completion of project.

C. Touch-up, damaged coatings and finishes and repair minor damage before Substantial Completion.

END OF SECTION

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SECTION 09 21 16 - GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Non-load-bearing steel framing systems for interior partitions.
2. Suspension systems for interior ceilings and soffits.
3. Gypsum board.
4. Tile backing panels.
5. Acoustical accessories.
6. Trim accessories.
7. Joint treatment materials.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Non-load-bearing steel framing systems for interior partitions.
2. Suspension systems for interior ceilings and soffits.
3. Grid suspension systems for gypsum board ceilings.
4. Gypsum board products.
5. Acoustical accessories.
6. Trim accessories.
7. Joint treatment materials.

B. Shop Drawings:

1. When studs must be spliced to obtain vertical span required, provide engineered drawing detail, signed and sealed by the responsible design professional, indicating total height of wall, splice length, and type and frequency of fasteners.

C. Samples: For the following products:

1. Trim Accessories: Full-size Sample in 12-inch-long length for each trim accessory indicated.

1.3 INFORMATIONAL SUBMITTALS

A. Product Certificates: For each type of code-compliance certification for studs and tracks.

B. Evaluation Reports: For embossed, high-strength steel studs and firestop tracks from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

1.4 QUALITY ASSURANCE

A. Mockups: Build mockups of at least 100 sq. ft. in surface area to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Build mockups for each level of gypsum board finish indicated for use in exposed locations.
2. Apply or install final decoration indicated, including painting and wallcoverings, on exposed surfaces for review of mockups.
3. Simulate finished lighting conditions for review of mockups.

4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Comply with ASTM C840 requirements or gypsum board manufacturer's written instructions, whichever are more stringent.

B. Do not install paper-faced gypsum panels until installation areas are enclosed and conditioned.

C. Do not install panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials identical to those tested in UL design assemblies indicated on Drawings according to ASTM E119 by an independent testing agency.

B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E90 and classified according to ASTM E413 by an independent testing agency.

C. Horizontal Deflection: For composite wall assemblies, limited to 1/240 of the wall height based on horizontal loading of 5 lbf/sq. ft.

2.2 FRAMING SYSTEMS

A. Framing Members, General: Comply with ASTM C754 for conditions indicated.

1. Steel Sheet Components: Comply with ASTM C645 requirements for steel unless otherwise indicated.
2. Protective Coating: Coating with equivalent corrosion resistance of ASTM A653/A653M, G40, hot-dip galvanized unless otherwise indicated.

B. Studs and Tracks: ASTM C645. Use either conventional steel studs and tracks or embossed, high-strength steel studs and tracks.

1. Steel Studs and Tracks:

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1) CEMCO; California Expanded Metal Products Co.
2) ClarkDietrich.
3) Custom Stud.
4) MarinoWARE.
5) MBA Building Supplies.
6) Phillips Manufacturing Co.
7) SCAFCO Steel Stud Company.
8) Steel Construction Systems.
9) Telling Industries.
10) The Steel Network, Inc.

b. Minimum Base-Steel Thickness: As indicated on Drawings, in correlation with vertical unbraced span and horizontal deflection performance requirements.
c. Depth: As indicated on Drawings
d. Spacing: As indicated on Drawings.
e. Application: Permitted for use in all applications except STC-rated assemblies.

2. Embossed, High Strength Steel Studs and Tracks: Roll-formed and embossed with surface deformations to stiffen the framing members so that they are structurally comparable to conventional ASTM C645 steel studs and tracks.

a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1) CEMCO; California Expanded Metal Products Co.
2) ClarkDietrich.
3) MarinoWARE.
4) MBA Building Supplies.
5) Phillips Manufacturing Co.
6) SCAFCO Steel Stud Company.
7) Steel Construction Systems.
8) Telling Industries.
9) The Steel Network, Inc.

b. Minimum Base-Steel Thickness: As indicated on Drawings, in correlation with vertical unbraced span and horizontal deflection performance requirements.
c. Depth: As indicated on Drawings.
d. Spacing:

1) 24-inches on center unless otherwise indicated.

e. Application:

1) STC-rated assemblies.
2) Permitted for all other applications except partitions scheduled to receive ceramic, glass, or stone tile.

3. High-Performing Acoustical Partition Wall Studs: Factory-assembled 3-5/8 inches (92 mm), 4 inches (101.6 mm), or 6 inches (152.4 mm) sound isolating double

stud using closed cell foam isolators creating sound dampening air gap. Use standard track.

a. Basis-of-Design Product: Subject to compliance with requirements, provide SoundGuard Stud by one of the following:

1) Marino\WARE
2) SCAFCO

b. Minimum Base-Metal Thickness: As required by horizontal deflection performance requirements, but not less than 0.019 inch (0.483 mm), (formerly 25 gage).
c. Depth: As indicated on Drawings.

C. Slip-Type Head Joints: Provide one or more of the following as required to accommodate anticipated floor or roof structure deflection:

1. Single Long-Leg Track System: ASTM C645 top track with 4 inches deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top track and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
2. Double-Track System: ASTM C645 top outer tracks, inside track with 2-inch-deep flanges in thickness not less than indicated for studs and fastened to studs, and outer track sized to friction-fit over inner track.
3. Deflection Track: Steel sheet top track manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above and allowing 1-1/2 inches minimum vertical movement; in thickness not less than indicated for studs and in width to accommodate depth of studs.

a. Products: Subject to compliance with requirements, provide one of the following:

1) CEMCO; California Expanded Metal Products Co.; CST Slotted Deflection Track.
2) ClarkDietrich; MaxTrak Slotted Deflection Track.
3) MarinoWARE; Slotted Track.
4) Perfect Wall, Inc.; The System Slotted Deflection Track.
5) SCAFCO Steel Stud Company; SDLT-Slotted Leg Track System.
6) Steel Construction Systems; SDLT-Slotted Leg Track System.
7) Telling Industries; Interior Slotted Track.

D. Firestop Tracks: Provide one or more of the following as required to accommodate anticipated floor or roof structure deflection:

1. Top track manufactured to allow partition heads to expand and contract with movement of structure while maintaining continuity of fire-resistance-rated assembly indicated and allowing up to 2 inches vertical movement; in thickness not less than indicated for studs and in width to accommodate depth of studs.

a. Products: Subject to compliance with requirements, provide one of the following:

1) CEMCO; California Expanded Metal Products Co.; FAS Track.
2) MarinoWARE; FAS Track 1000.
3) Perfect Wall, Inc.; The System Slotted Deflection Track.

4) SCAFCO Steel Stud Company; SCAFCO Slotted Leg Track System.
5) Steel Construction Systems; Steel-Con Slotted Leg Track System.

E. Acoustical Tracks: For STC-rated assemblies, provide the following as required to accommodate anticipated floor or roof structure deflection:

1. Top track manufactured with a 5/8-inch or 1-1/4" offset shoulder to allow partition heads to expand and contract with movement of structure while maintaining continuity of STC-rated assembly indicated and allowing up to 4 inches vertical movement; in thickness not less than indicated for studs and in width to accommodate depth of studs.

a. Product: Subject to compliance with requirements, provide one of the following:

1) ClarkDietrich; BlazeFrame RipTRAK attached to studs with RTC-33-RipTRAK Clips.
2) Fire Trak Corp; Fire Trak Shadowline attached to studs with Fire Trak PosiKlip.

F. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.

1. Minimum Base-Steel Thickness: 0.0538-inch.

G. Cold-Rolled Channel Bridging: Steel, 0.0538-inch minimum base-steel thickness, with minimum 1/2-inch-wide flanges.

1. Depth: 1-1/2 inches.
2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch-thick, galvanized steel.

H. Hat-Shaped, Rigid Furring Channels: ASTM C645.

1. Minimum Base-Steel Thickness: 0.0296 inch.
2. Depth: 7/8 inch.

I. Cold-Rolled Furring Channels: 0.053-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges.

1. Depth: 3/4 inch.
2. Furring Brackets: Adjustable, corrugated-edge-type steel sheet with minimum uncoated-steel thickness of 0.0329 inch.
3. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch-diameter wire.

J. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches, wall attachment flange of 7/8 inch, minimum uncoated-steel thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.

2.3 SUSPENSION SYSTEMS

A. Tie Wire: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.062-inch-diameter wire, or double strand of 0.048-inch-diameter wire.

B. Hanger Attachments to Concrete:

1. Post-Installed Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC01 AC193 AC58 or AC308 as appropriate for the substrate.
    a. Material: Carbon-steel components zinc-plated to comply with ASTM B633 or ASTM F1941, Class Fe/Zn 5, unless otherwise indicated.
2. Power-Actuated Anchors: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.

C. Wire Hangers: ASTM A641/A641M, Class 1 zinc coating, soft temper, 0.16 inch in diameter.

D. Carrying Channels (Main Runners): Cold-rolled, commercial-steel sheet with a base-steel thickness of 0.0538 inch and minimum 1/2-inch-wide flanges.

1. Depth: 2 inches.

E. Furring Channels (Furring Members):

1. Cold-Rolled Channels: 0.0538-inch uncoated-steel thickness, with minimum 1/2-inch-wide flanges, 3/4 inch deep.
2. Steel Studs and Tracks: ASTM C645.
    a. Minimum Base-Steel Thickness: 0.0296 inch.
    b. Depth: As indicated on Drawings.
3. Embossed, High-Strength Steel Studs and Tracks: ASTM C645.
    a. Minimum Base-Steel Thickness: 0.0190 inch.
    b. Depth: As indicated on Drawings.
4. Hat-Shaped, Rigid Furring Channels: ASTM C645, 7/8 inch deep.
    a. Minimum Base-Steel Thickness: 0.0296 inch.

F. Grid Suspension System for Gypsum Board Ceilings: ASTM C645, direct-hung system composed of main beams and cross-furring members that interlock.

1. Products: Subject to compliance with requirements, provide one of the following:
    a. Armstrong Ceiling & Wall Solutions; Drywall Grid Systems.
    b. Rockfon (Rockwool International); 640/660 Drywall Ceiling Suspension.
    c. USG Corporation; Drywall Suspension System.

2.4 GYPSUM BOARD, GENERAL

A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.5 INTERIOR GYPSUM BOARD

A. Gypsum Board: ASTM C1396/C1396M.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. American Gypsum.
    b. CertainTeed Gypsum.
    c. Georgia-Pacific Gypsum LLC.

d. National Gypsum Company.
e. PABCO Gypsum.
f. USG Corporation.

2. Core: 5/8-inch, Type X, unless otherwise indicated.

B. Flexible Gypsum Board: ASTM C1396/C1396M. Manufactured to bend to fit radii and to be more flexible than standard regular-type gypsum board of same thickness.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. CertainTeed Gypsum.
b. Georgia-Pacific Gypsum LLC.
c. National Gypsum Company.
d. PABCO Gypsum.
e. USG Corporation.

2. Thickness: 1/4 inch.
3. Long Edges: Tapered.

C. Mold-Resistant Gypsum Board: ASTM C1396/C1396M. With moisture- and mold-resistant core and paper surfaces.

1. Products: Subject to compliance with requirements, provide one of the following:

a. American Gypsum; M-Bloc® Type X with Mold & Moisture Resistance.
b. CertainTeed Gypsum; CertainTeed M2Tech Mold and Moisture Resistant Type X Gypsum Board.
c. National Gypsum Company; Gold Bond® XP® Fire-Shield® Gypsum Board.
d. PABCO Gypsum; MOLD CURB® Plus.
e. USG Corporation; USG Sheetrock® Brand Mold Tough® Firecode® X Panels.

2. Core: 5/8-inch, Type X.
3. Long Edges: Tapered.
4. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

D. Acoustically Enhanced Gypsum Board: ASTM C1396/C1396M. Multilayer products constructed of two layers of gypsum boards sandwiching a viscoelastic sound-absorbing polymer core.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Gypsum; CertainTeed SilentFX QuickCut Type X Acoustical Gypsum Board.
b. National Gypsum Company; Gold Bond® SoundBreak XP™ Retrofit™ Board.
c. PABCO Gypsum; QuietRock® ES.

2. Core: 5/8 inch (15.9 mm), Type X.
3. Long Edges: Tapered.

2.6 TILE BACKING PANELS

A. Glass-Mat, Water-Resistant Backing Board: ASTM C1178/C1178M, with manufacturer's standard edges.

1. Products: Subject to compliance with requirements, provide one of the following:
    a. CertainTeed Corporation; GlasRoc Tile Backer.
    b. Georgia-Pacific Gypsum LLC; DensShield Tile Backer.
    c. National Gypsum Company; Gold Bond® eXP® Tile Backer.
    d. USG Corporation; USG Durock™ Glass-Mat Tile Backerboard.
2. Core: 5/8 inch, Type X.
3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

B. Cementitious Backer Units: ANSI A118.9 and ASTM C1288 or ASTM C1325, with manufacturer's standard edges.

1. Products: Subject to compliance with requirements, provide one of the following:
    a. FinPan, Inc; Util-A-Crete Concrete Backer Board.
    b. National Gypsum Company; PermaBase® Cement Board.
    c. USG Corporation; DUROCK Cement Board.
2. Thickness: 5/8 inch.
3. Mold Resistance: ASTM D3273, score of 10 as rated according to ASTM D3274.

2.7 ACOUSTICAL ACCESSORIES

A. Sound-Attenuation Blankets: ASTM C665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.

1. Products: Subject to compliance with requirements, provide one of the following:
    a. CertainTeed Corporation; NoiseReducer™.
    b. Johns Manville; a Berkshire Hathaway company; Formaldehyde-free™ Unfaced thermal and acoustical batts.
    c. Knauf Insulation; EcoBatt® Insulation.
    d. Owens Corning; EcoTouch® Sonobatts Insulation.
2. Flame-Spread Index: Not more than 25 when tested in accordance with ASTM E84.
3. Smoke-Developed Index: Not more than 50 when tested in accordance with ASTM E84.

B. Electrical J-Box Putty Pads: Preformed, moldable putty pads formulated to maintain the performance of acoustically rated wall assemblies by sealing penetrations including common electrical outlets boxes, phone outlet boxes, electrical switches, HVAC ducts, and plumbing connections.

1. Products: Subject to compliance with requirements, provide one of the following:
    a. ATS Acoustics; ATS Acoustics Putty Pads.
    b. The Soundproofing Company Inc.; Acoustical Putty Pads.
    c. QuietRock; QuietPutty.

C. Acoustical Sealant for Exposed and Concealed Joints: Manufacturer's standard nonsag, paintable, nonstaining latex acoustical sealant complying with ASTM C834.

1. Products: Subject to compliance with requirements, provide one of the following:

a. GE Construction Sealants; Momentive Performance Materials Inc.; RCS20 Acoustical.
b. Hilti, Inc.; CP 506 Smoke and Acoustical Sealant.
c. QuietRock; QuietSeal Pro.
d. Specified Technologies, Inc.; SpecSeal Smoke 'N' Sound Sealant.
e. Tremco Incorporated; Tremco Acoustical Sealant.
f. USG Corporation; SHEETROCK Acoustical Sealant.

2. Colors of Exposed Acoustical Joint Sealants: White.

D. Resilient Sound Isolation Clips: Isolation clips consisting of a steel and rubber component, designed to receive standard 7/8-inch, hat-shaped, rigid furring channels, and isolate framing members from metal-to-metal or other rigid contact.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Kinetics Noise Control; IsoMax.
b. PAC International, LLC; RSIC-1.
c. Pliteq, Inc.; GenieClip RST.

2.8 TRIM ACCESSORIES

A. Interior Trim: ASTM C1047, galvanized or aluminum-coated steel sheet, rolled zinc, or paper-faced galvanized-steel sheet.

1. Edge Shapes:

a. Cornerbead.
b. Bullnose bead.
c. LC-Bead: J-shaped; exposed long flange receives joint compound.
d. L-Bead: L-shaped; exposed long flange receives joint compound.
e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
f. Curved-Edge Cornerbead: With notched or flexible flanges.

2. Expansion (Control) Joints.
3. Fire-Rated Expansion (Control) Joints: Composite control joint with intumescent tape factory applied to back of control joint on one side.

a. Products: Subject to compliance with requirements, provide the following:

1) ClarkDietrich; FAS-093X Fire Rated Control Joint.

B. Base-of-Wall PVC Moisture Barrier Trim: Extruded PVC, 1/2 inch high.

1. Products: Subject to compliance with requirements, provide the following:

a. Waterguard; Waterguard.

C. Extruded Aluminum Trim Accessories: Aluminum: Alloy and temper with not less than the strength and durability properties of ASTM B221, Alloy 6063-T5, of profiles and dimensions indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Fry Reglet Corp.
b. Gordon, Inc.
c. Pittcon Industries.

2. Finish and Profile: As indicated on Drawings.

D. Fire-Rated Reveal Backer: 0.0359 inchthick, ASTM A653/A653M, hot-dip galvanized, ASTM C645 flat steel strap backer plate with an affixed cured intumescent strip to maintain fire ratings behind architectural reveal moldings in fire-rated partitions.

1. Products: Subject to compliance with requirements, provide the following:

a. ClarkDietrich; BlazeFrame® “FSB” (Flat Strap Backer).

2.9 AUXILIARY MATERIALS

A. Provide auxiliary materials that comply with referenced installation standards and manufacturer's written instructions.

B. Floor Track Seal: Provide the following where indicated:

1. Foam Gasket: Adhesive-backed, closed-cell vinyl foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

C. Fasteners for Steel Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.

D. Steel Drill Screws For Gypsum Board: ASTM C1002 unless otherwise indicated.

1. Use screws complying with ASTM C954 for fastening panels to steel members from 0.033 to 0.112 inch thick.
2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.

E. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.

2.10 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C475/C475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper.
2. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat, use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:

1) National Gypsum Company; Proform Quick Set 210 Setting Compound.
2) USG Corporation; Sheetrock Durabond 210 Setting-Type Joint Compound.

2. Fill Coat: For second coat, use setting-type, sandable topping compound.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:

1) National Gypsum Company; Proform Quick Set 90 Setting Compound.
2) USG Corporation; Sheetrock Durabond 90 Setting-Type Joint Compound.

3. Finish Coat: For third coat, use drying-type, all-purpose compound.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:

1) National Gypsum Company; Proform All Purpose Joint Compound, Ready-Mixed.
2) USG Corporation; Sheetrock Brand All Purpose Joint Compound, Ready-Mixed.

4. Skim Coat: For final coat of Level 5 finish, use drying-type, all-purpose compound.

a. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to the following:

1) National Gypsum Company; Proform Lite Joint Compound, Ready-Mixed.
2) USG Corporation; Sheetrock Brand Lightweight Joint Compound, Ready-Mixed.

D. Joint Compound for Tile Backing Panels:

1. Glass-Mat, Water-Resistant Backing Panel: As recommended by backing panel manufacturer.
2. Cementitious Backer Units: As recommended by backer unit manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames, cast-in anchors, and support framing, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine panels before installation. Reject panels that are wet, moisture damaged, and mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Installation Standard: ASTM C754.

1. Gypsum Board Assemblies: Also comply with requirements in ASTM C 840 that apply to framing installation.

B. Install framing and accessories plumb, square, and true to line, with connections securely fastened.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.

D. Install bracing at terminations in assemblies.

E. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.3 INSTALLING FRAMED ASSEMBLIES

A. Install framing system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

B. Where studs are installed directly against exterior masonry walls or dissimilar metals at exterior walls, install isolation strip between studs and exterior wall.

C. Install studs so flanges within framing system point in same direction.

D. Install tracks at floors and overhead supports. Extend framing full height to structural supports or substrates above suspended ceilings except where partitions are indicated to terminate at suspended ceilings. Continue framing around and above ducts that penetrate partitions above ceiling.

1. Slip-Type Head Joints: Where framing extends to overhead structural supports, install to produce joints at tops of framing systems that prevent axial loading of finished assemblies.
2. Door Openings: Screw vertical studs at jambs to jamb anchor clips on door frames; install track section (for cripple studs) at head and secure to jamb studs.
    a. Install two studs at each jamb unless otherwise indicated.
    b. Install cripple studs at head adjacent to each jamb stud, with a minimum 1/2-inch clearance from jamb stud to allow for installation of control joint in finished assembly.
    c. Extend both jamb studs through suspended ceilings and attach to underside of overhead structure.
3. Other Framed Openings: Frame openings other than door openings the same as required for door openings unless otherwise indicated. Install framing below sills of openings to match framing required above door heads.
4. Fire-Resistance-Rated Partitions: Install framing to comply with fire-resistance-rated assembly indicated and support closures and to make partitions continuous from floor to underside of solid structure.
    a. Firestop Track: Install to maintain continuity of fire-resistance-rated assembly indicated.
5. Sound-Rated Partitions: Install framing to comply with sound-rated assembly indicated.
    a. Acoustical Tracks: Install to maintain continuity of STC-rated assembly indicated.
    b. Double Stud Walls and High-Performing Acoustical Partition Wall Studs:
        1) Do not acoustically short-circuit independent rows of studs by bracing together with rigid framing members.

2) Do not allow rigid piping within chase walls to be connect to framing members with metal or other rigid pipe connectors. Use resilient pipe connectors.

6. Curved Partitions:

a. Bend track to uniform curve and locate straight lengths so they are tangent to arcs.
b. Begin and end each arc with a stud, and space intermediate studs equally along arcs. On straight lengths of no fewer than two studs at ends of arcs, place studs 6 inches o.c.

E. Direct Furring:

1. Attach to concrete or masonry with stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.

F. Z-Shaped Furring Members:

1. Erect insulation, specified in Section 07 21 00 "Thermal Insulation," vertically and hold in place with Z-shaped furring members spaced 24 inches o.c.
2. Except at exterior corners, securely attach narrow flanges of furring members to wall with concrete stub nails, screws designed for masonry attachment, or powder-driven fasteners spaced 24 inches o.c.
3. At exterior corners, attach wide flange of furring members to wall with short flange extending beyond corner; on adjacent wall surface, screw-attach short flange of furring channel to web of attached channel. At interior corners, space second member no more than 12 inches from corner and cut insulation to fit.

G. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.4 INSTALLING CEILING SUSPENSION SYSTEMS

A. Install suspension system components according to spacings indicated, but not greater than spacings required by referenced installation standards for assembly types.

1. Hangers: 48 inches o.c.
2. Carrying Channels (Main Runners): 48 inches o.c.
3. Furring Channels (Furring Members): 16 inches o.c.

B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.

C. Suspend hangers from building structure as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.

a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.

2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.

a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by ASTM C 754.

3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
4. Do not attach hangers to steel roof deck.
5. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
6. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.
7. Do not connect or suspend steel framing from ducts, pipes, or conduit.

D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.

E. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.

F. Installation Tolerances:

1. Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.
2. Where sprinkler heads, diffusers, and speakers are arranged in alignment, variation from exact alignment shall not vary more than 1/2-inch either side of centerline through various element openings.

3.5 INSTALLATION AND FINISHING OF PANELS, GENERAL

A. Comply with ASTM C840.

B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.

C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.

D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back-blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.

E. Form control and expansion joints with space between edges of adjoining gypsum panels.

F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.

1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
2. Fit gypsum panels around ducts, pipes, and conduits.

3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch-wide joints to install sealant.

G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments. Provide 1/4- to 1/2-inch-wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.

H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

I. STC-Rated Assemblies:

1. At top-of-wall conditions below metal floor or roof decks, castle-cut gypsum panels to match profile deck.
2. Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations.
3. Comply with ASTM C919 and with manufacturer's written instructions for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.

J. Install sound attenuation blankets in STC-rated assemblies before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.6 INSTALLATION OF INTERIOR GYPSUM BOARD

A. Install interior gypsum board in the following locations:

1. Type X: All framed surfaces unless otherwise indicated.
2. Flexible Type: Apply in double layer at curved assemblies.
3. Mold-Resistant Type: At all framed interior surfaces of exterior walls and all framed surfaces where construction will not be fully protected from potential weather exposure at time of installation.
4. Acoustically Enhanced Type: As indicated on Drawings.

B. Single-Layer Application:

1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
2. On partitions/walls, apply gypsum panels vertically (parallel to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.

    a. Stagger abutting end joints not less than 24 inches in alternate courses of panels.
    b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.

3. On Z-shaped furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.

C. Multilayer Application:

1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
3. On Z-shaped furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
4. Fastening Methods: Fasten base layers with screws; fasten face layers with adhesive and supplementary fasteners.

D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written instructions and temporarily brace or fasten gypsum panels until fastening adhesive has set.

E. Curved Surfaces:

1. Install panels horizontally (perpendicular to supports) and unbroken, to extent possible, across curved surface plus 12-inch-long straight sections at ends of curves and tangent to them.
2. For double-layer construction, fasten base layer to studs with screws 16 inches o.c. Center gypsum board face layer over joints in base layer, and fasten to studs with screws spaced 12 inches o.c.

3.7 INSTALLATION OF TILE BACKING PANELS

A. Install tile backing panels in the following locations:

1. All framed surfaces indicated to receive tile.

B. Glass-Mat, Water-Resistant Backing Panels: Comply with manufacturer's written installation instructions and install at locations indicated to receive tile less than or equal to 1.4 sq. ft. in area or 5 lb./sq. ft. in weight. Install with 1/4-inch gap where panels abut other construction or penetrations.

C. Cementitious Backer Units: ANSI A108.11, at locations indicated to receive tile greater than 1.4 sq. ft. in area or 5 lb./sq. ft. in weight.

D. Where tile backing panels abut other types of panels in same plane, shim framed surfaces to produce a uniform plane across panel surfaces.

3.8 INSTALLATION OF ACOUSTICAL ACCESSORIES

A. Place acoustical insulation in STC-rated partitions tight within spaces, around cut openings, behind and around electrical and mechanical items within or behind partitions, and tight to items passing through partitions.

B. Install electrical J-box putty pads at STC-rated partitions in accordance with manufacturer's instructions.

C. Install resilient sound isolation clips at STC-rated partitions indicated to receive rigid furring channels to avoid metal-to-metal or other rigid substrate contact.

D. Install acoustical sealant at STC-rated partitions in accordance with manufacturer's instructions.

3.9 INSTALLATION OF TRIM ACCESSORIES

A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.

B. Control Joints: Maintain fire ratings of assemblies at control joints. Install control joints according to ASTM C840 and as follows:

1. Partitions: Install control joints:

   a. no greater than 30 feet on center where a partition runs in an uninterrupted straight plane;
   b. at both corners of openings in wall planes, above and below opening, where width of opening is 6 feet or greater, or where ratio of width to height of wall area above or below opening exceeds 4:1;
   c. at all spliced joints of vertical studs;
   d. at other locations indicated on Drawings.

2. Ceilings: Install control joints:

   a. no greater than 30 feet on center and with total area not to exceed 900 sq. ft.;
   b. where sections of "A," "L," "O," "U," "T" and "X" shaped ceiling areas or furr-down areas intersect;
   c. at other locations indicated on Drawings.

C. Interior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners unless otherwise indicated.
2. Bullnose Bead: Use where indicated on Drawings.
3. LC-Bead: Use at exposed panel edges.
4. L-Bead: Use where edge trim can only be installed after gypsum board is installed.
5. U-Bead: Use at exposed panel edges not intended to receive joint compound.
6. Curved-Edge Cornerbead: Use at curved openings.

D. Aluminum Trim: Maintain fire ratings of assemblies at aluminum trim. Install in locations indicated on Drawings.

3.10 FINISHING GYPSUM BOARD

A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.

B. Prefill open joints, rounded or beveled edges, and damaged surface areas.

C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.

D. Gypsum Board Finish Levels:

1. Level 0: No taping, finishing, or accessories required.
2. Level 1:
    a. Joints: Tape set in joint compound.
    b. Interior Angles: Tape set in joint compound.
    c. Surface: Tool marks and ridges acceptable. Surface free of excess joint compound.
3. Level 2:
    a. Joints: Tape embedded in joint compound and wiped with a joint knife, leaving a thin coat of compound over tape.
    b. Interior Angles: Tape embedded in joint compound and wiped with a joint knife, leaving a thin coat of compound over tape.
    c. Accessories: Shall be covered to one separate coat of joint compound.
    d. Fasteners: Shall be covered by one separate coat of joint compound.
    e. Surface: Surface shall be free of excess joint compound. Tool marks and ridges acceptable. Joint compound applied over the body of the tape at the time of tape embedment shall be considered a separate coat of joint compound and shall satisfy the conditions of this level.
4. Level 3:
    a. Joints: Taped as in Level 2, then covered with one separate coat of joint compound.
    b. Interior Angles: Taped as in Level 2, then covered with one separate coat of joint compound.
    c. Accessories: Shall be covered by two separate coats of joint compound.
    d. Fasteners: Shall be covered by two separate coats of joint compound.
    e. Surface: Joint compound shall be smooth and free of tool marks and ridges.
5. Level 4:
    a. Joints: Taped as in Level 2, then covered with two separate coats of joint compound.
    b. Interior Angles: Taped as in Level 2, then covered with one separate coat of joint compound.
    c. Accessories: Shall be covered by three separate coats of joint compound.
    d. Fasteners: Shall be covered by three separate coats of joint compound.
    e. Surface: Joint compound shall be smooth and free of tool marks and ridges.
6. Level 5:
    a. Joints: Taped as in Level 2, then covered with two separate coats of joint compound.
    b. Interior Angles: Taped as in Level 2, then covered with one separate coat of joint compound.
    c. Accessories: Shall be covered by three separate coats of joint compound.
    d. Fasteners: Shall be covered by three separate coats of joint compound.

e. Surface: A thin skin coat of joint compound, or a material manufactured especially for this purpose, shall be applied to the entire surface. The surface shall be smooth and free of tool marks and ridges.

E. Gypsum Board Finish Level Schedule: Finish panels to levels indicated below and according to ASTM C840:

1. Level 0: Temporary construction or where final finishes have not yet been determined. Do not use in areas where fire ratings or smoke control are required.
2. Level 1: Ceiling plenum areas, concealed areas, service corridors and other areas not normally exposed to view.
3. Level 2: Panels that are substrates for tile.
4. Level 3: Areas which are to receive heavy or medium, spray or troweled, texture finishes before final painting and areas where heavy grade wall coverings are to be applied as the final finish.
5. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
   a. Primer and its application to surfaces are specified in Section 09 91 23 "Interior Painting."
6. Level 5: At panel surfaces flooded with natural or artificial light and scheduled to receive semi-gloss or gloss paint finish.
   a. Primer and its application to surfaces are specified in Section 09 91 23 "Interior Painting."

F. Glass-Mat Faced Panels: Finish according to manufacturer's written instructions.

G. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.11 PROTECTION

A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.

B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.

C. Remove and replace panels that are wet, moisture damaged, and mold damaged.

1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION

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SECTION 09 51 13 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes acoustical panels and exposed suspension systems for ceilings.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below.

1. Acoustical Panel: Set of 6-inch-square Samples of each type, color, pattern, and texture.
2. Exposed Suspension-System Members, Moldings, and Trim: Set of 6-inch-long Samples of each type, finish, and color.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance Data: For finishes to include in maintenance manuals.

1.4 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockup of typical ceiling area as shown on Drawings.
2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical panels, suspension-system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes.

B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.

C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.6 FIELD CONDITIONS

A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, wet work in spaces is complete and dry, work above ceilings is complete, and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.

1. Pressurized Plenums: Operate ventilation system for not less than 48 hours before beginning acoustical panel ceiling installation.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Acoustical ceiling shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: Comply with ASTM E 1264 for Class A materials.
2. Smoke-Developed Index: 50 or less.

2.2 ACOUSTICAL PANELS, GENERAL

A. Glass-Fiber-Based Panels: Made with binder containing no urea formaldehyde.

B. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances unless otherwise indicated.

2.3 ACOUSTICAL PANELS

A. Basis-of-Design Product: Subject to compliance with requirements, provide products indicated on Drawings.

2.4 METAL SUSPENSION SYSTEMS, GENERAL

A. Metal Suspension-System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635/C 635M.

1. High-Humidity Finish: Comply with ASTM C 635/C 635M requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.

B. Attachment Devices: Size for five times the design load indicated in ASTM C 635/C 635M, Table 1, "Direct Hung," unless otherwise indicated. Comply with seismic design requirements.

1. Anchors in Concrete: Anchors of type and material indicated below, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.

    a. Type: Postinstalled expansion or bonded anchors.
    b. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.

2. Power-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to 10 times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.

C. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:

1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
2. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304, nonmagnetic.
3. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635/C 635M, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch-diameter wire.

D. Flat Hangers: Mild steel, zinc coated or protected with rust-inhibitive paint.

E. Angle Hangers: Angles with legs not less than 7/8 inch wide; formed with 0.04-inch-thick, galvanized-steel sheet complying with ASTM A 653/A 653M, G90 coating designation; with bolted connections and 5/16-inch-diameter bolts.

F. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.

G. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

H. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical panels in place.

2.5 METAL SUSPENSION SYSTEM

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings.

B. Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet; prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 coating designation; with prefinished flanges.

1. Structural Classification: Intermediate-duty system.
2. End Condition of Cross Runners: Override (stepped) or butt-edge type.

2.6 METAL EDGE MOLDINGS AND TRIM

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings.

B. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements and the following:

1. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221 for Alloy and Temper 6063-T5.
2. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
3. Baked-Enamel or Powder-Coat Finish: Minimum dry film thickness of 1.5 mils. Comply with ASTM C 635/C 635M and coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.

2.7 ACOUSTICAL SEALANT

A. Acoustical Sealant: Manufacturer's standard sealant complying with ASTM C 834 and effective in reducing airborne sound transmission through perimeter joints and openings in building construction as demonstrated by testing representative assemblies according to ASTM E 90.

1. Exposed and Concealed Joints: Nonsag, paintable, nonstaining latex sealant.
2. Concealed Joints: Nondrying, nonhardening, nonskinning, nonstaining, gunnable, synthetic-rubber sealant.
3. Acoustical sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.

B. Examine acoustical panels before installation. Reject acoustical panels that are wet, moisture damaged, or mold damaged.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION

A. General: Install acoustical panel ceilings to comply with ASTM C 636/C 636M and seismic design requirements indicated, according to manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

1. Fire-Rated Assembly: Install fire-rated ceiling systems according to tested fire-rated design.

B. Suspend ceiling hangers from building's structural members and as follows:

1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structure or of ceiling suspension system.
2. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
4. Secure wire hangers to ceiling-suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
5. Secure flat, angle, channel, and rod hangers to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices that are secure and appropriate for both the structure to which hangers are attached and the type of hanger involved. Install hangers in a manner that will not cause them to deteriorate or fail due to age, corrosion, or elevated temperatures.
6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to postinstalled mechanical or adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
7. When steel framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
8. Do not attach hangers to steel deck tabs.
9. Do not attach hangers to steel roof deck. Attach hangers to structural members.
10. Space hangers not more than 48 inches o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches from ends of each member.
11. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.

C. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.

1. Apply acoustical sealant in a continuous ribbon concealed on back of vertical legs of moldings before they are installed.
2. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
3. Do not use exposed fasteners, including pop rivets, on moldings and trim.

D. Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

E. Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.

1. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
2. For reveal-edged panels on suspension-system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
3. For reveal-edged panels on suspension-system members with box-shaped flanges, install panels with reveal surfaces in firm contact with suspension-system surfaces and panel faces flush with bottom face of runners.
4. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
5. Protect lighting fixtures and air ducts to comply with requirements indicated for fire-resistance-rated assembly.

3.4 CLEANING

A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Comply with manufacturer's written instructions for cleaning and touchup of minor finish damage. Remove and replace ceiling components that cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

END OF SECTION

SECTION 09 67 23 - RESINOUS FLOORING AND COATINGS

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Urethane Concrete Flooring.

1. Slurry-applied urethane cement composition flooring with slip resistant broadcast. (Dex-O-Tex Tek-Crete SL-B)

1.2 REFERENCES

A. American Standard Test Method International (ASTM):

1. ASTM C307 - Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings.
2. ASTM C531 - Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
3. ASTM C579 - Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
4. ASTM C580 - Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
5. ASTM D882 - Standard Test Method for Tensile Properties of Thin Plastic Sheeting.
6. ASTM D1308 - Standard Test Method for Effect of Household Chemicals on Clear and Pigmented Organic Finishes.
7. ASTM D2240 - Standard Test Method for Rubber Property-Durometer Hardness.
8. ASTM D4060 - Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
9. ASDTM D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
10. ASTM E648 - Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.
11. ASTM F1679 - Standard Test Method for Using a Variable Incidence Tribometer (VIT).
12. ASTM F1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
13. ASTM F2170 - Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.
14. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi.

B. American Concrete Institute (ACI):

1. ACI 503.1 - Standard Specification for Bonding Hardened Concrete, Steel, Wood, Brick, and Other Materials to Hardened Concrete with a Multi-Component Epoxy Adhesive.

C. American National Standards Institute (ANSI):

1. ANSI A1264 - American National Standard for the Provision of Slip Resistance on Walking/Working Surfaces.

D. International Concrete Repair Institute (ICRI):

1. ICRI - 310.25 Selecting and Specifying Concrete Surface Preparation.

E. National fire Protection Association (NFPA):

1. NFPA 56A - Standard for the Use of Inhalation Anesthetics.

F. Society of Protective Coatings (SSPC):

1. SSPC - Monitoring and Controlling Ambient Condition During Coating operations.
2. SSPC TU-10 - Procedures For Applying Thick Film Coatings and Surfacings Over Concrete Floors.
3. SSPC TR-5 - Design, Installation, and Maintenance of Protective Polymer Flooring Systems for Concrete.
4. SSPC TECHNOLOGY GUIDE NO. 10 - Guide to Specifying Coatings Conforming to Volatile Organic Compound (VOC) Content Requirements.
5. SSPC-SP 13/NACE No. 6 - Surface Preparation of Concrete.

G. United States Defense Standard (MIL):

1. MIL-D-3134 - Deck Covering Materials.
2. MIL-PRF-3135 - Performance Specification: Deck Covering Underlay Materials.

1.3 SUBMITTALS

A. Product Data:

1. Manufacturer's data sheets on each product to be used.
2. Preparation instructions and recommendations.
3. Storage and handling requirements and recommendations.

B. Verification Samples: For products specified, two samples, 6 inches (150 mm) square representing actual product, color, texture ranges and patterns.

C. Shop Drawings: Details of materials, construction and finish. Include relationship with adjacent construction.

D. Contractor Certification: Manufacturer letter certifying installer is properly trained in application of materials being installed and is acceptable to materials manufacturer.

E. Guarantee Certification: Letter from the primary materials manufacture certifying that the manufacturer will issue a joint Installer/Manufacturer warranty with the installing contractor.

F. Certification: CA Department of Public Health 01350 Method for Testing and Evaluation of Volatile Organic Chemical Emissions From Indoor Sources Using Environmental Chambers.

G. Closeout Submittals:

1. Care and Maintenance Data

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section with ISO certification, or in the process of said certification, and a minimum of 10 years documented experience.

B. Installer Qualifications:

1. Firm specializing in work of this section with a minimum 5 years experience.
2. Written approval by the flooring manufacturer.

1.5 REGULATORY REQUIREMENTS:

A. Dynamic coefficient of friction: Minimum 0.60, tested to ANSI A326.3

B. Source Limitations: Sole Source Responsibility:

1. Obtain materials; including primers, resins, hardening agents, and finish or sealing coats, from a single manufacturer. Private Label materials will not be accepted
2. Provide secondary materials, including patching and fill materials, joint sealant, accessory items, etc.. from a source recommended by the manufacturer of the primary materials
3. Private label materials will not be accepted.

C. Mock-Up: Mock-Up: If logistics permit, construct a 10’ x 10’ mock up with actual materials in sufficient time for Architect's review and to not delay construction progress. Locate mock-up as acceptable to Architect and provide temporary foundations and support.

1. Intent of the mock-up is to demonstrate quality of workmanship, visual appearance and final finish and texture.
2. If mock-up is not acceptable, rebuild mock-up until satisfactory results are achieved.
3. Retain mock-up during construction as standard for comparison with completed work.
4. Do not alter or remove mock-up until work is completed or removal is authorized.

1.6 PRE-INSTALLATION CONFERENCE

A. Pre-installation Meetings: Coordinate work of this Section, with related work.

1. Attendance: Subcontractor performing work and manufacturers and fabricators involved, or affected by, installation. Coordinate installations that precede or follow.
2. Agenda: Review progress of construction activities and preparations for the particular activity under consideration. Agenda shall include schedule, drain and floor sink interface, detailing, door thresholds, responsibilities, critical path items, and approvals.
3. Record, agreements, and disagreements, and corrective measures and actions.
4. Reporting: Distribute minutes to each party present and others requiring information.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in original packages and containers with unbroken seals and bearing manufacturer's labels with date of manufacture and production lot number. Store and handle in strict compliance with manufacturer's written instructions and recommendations.

B. Protect from damage due to weather, excessive temperature, and construction operations.

C. When practical stage materials in area of Work 72 hours prior to beginning of Work.

1.8 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, surface temperature, material temperature and ventilation) within limits recommended by manufacturer during installation and cure. Do not install under conditions outside manufacturer's recommended limits.

B. Restrict access to Work area except installing contractor and site supervision during preparation, installation and cure period.

C. Lighting: Permanent lighting shall be in place prior to flooring installation.

1.9 WARRANTY

A. Manufacturer's Warranty: Provide a joint Contractor/Manufacturer's standard limited warranty for the specified term.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer:

1. Address: Crossfield Products Corporation, which is located at: 3000 E. Harcourt Street; Rancho Dominguez, CA 90221; ASD Phone: 310-886-9100; Fax: 310-886-9119; Email: info@dexotex.com Web: www.dexotex.com.
2. Address: Crossfield Products Corporation, which is located at: 140 Valley Road; Roselle Park, NJ 07204; ASD Phone: 908-245-2800; Fax: 908-245-0659; Email: info@dexotex.com; Web: www.dexotex.com.
3. Address: Crossfield Products Corporation, which is located at: 128 Industrial Drive, Cibolo, TX 78108; ASD Phone: 210-888-0449; Email: info@dexotex.com; Web: www.dexotex.com.

2.2 URETHANE CONCRETE FLOORING

A. Slurry-Applied Urethane Cement Composition Mortar with Slip Resistant Sand Broadcast:

1. Basis of Design: Dex-O-Tex Tek-Crete SL-B by Crossfield Products.
2. Physical Properties:

    a. Compressive Strength (ASTM C579): 6,100 psi (42.0 MPa).
    b. Thermal Distortion (250 degrees F Emersion): Passes.
    c. Tensile Strength (ASTM C307): 1,000 psi (6.89 MPa).

d. Flexural Strength (ASTM C580): 2,000 psi (13.8 MPa).
e. Thermal Co-Efficient of Thermal Expansion (ASTM C531): 1.4 x 10E5.
f. Density (ASTM C905): 130 pcf (20.4 kN/cu.m).
g. Water Absorption (MIL-PRF-3134): 0.64 percent.
h. Surface Hardness (ASTM D2240) 85-90 Durometer "D".
i. Abrasion Resistance (ASTM D1044): 33mg.
j. Adhesion (ASTM D4541): 400 psi (2.76 MPa), 100 percent failure in concrete.
k. Flammability-Critical Radiant Flux (ASTM E648): 1.07 watts/sq.cm.
l. Resistance to Fungal Growth (ASTM G21): Passes, Rating 1.

3. Underlayment – (If Required) Trowelable mortar recommended AND manufactured by the Flooring Manufacturer
4. Membrane – (If Required) Dex-O-Tex Cheminert SC Membrane applied in 2 coats with a sand broadcast per manufacturer's written recommendations.
5. Body Coat: 3/16 to 1/4 inch (5 to 6 mm), with sand broadcast to rejection.
6. Colors: _TBD – Reference Dex-O-Tex Color Charts for proper color selection.
7. Top Coat: Tek-Crete Sealer CP Pigmented Topcoat. Urethane cement, pigmented UV Stable Finish coat – Finished in 1 coat.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Do not begin preparation and installation until substrates are properly constructed and inspected complying with ACI 311.4R-05 Guide for Concrete Inspection. The General Contractor is to correct non-conformities if defects are discovered. Repair per ACI 546.R-04. Turn over work in broom clean condition free of debris and foreign matter.

B. If substrate preparation is responsibility of another contractor, inspect per ACI 311.4R-05 Guide for Concrete Inspection by a certified SSPC CCI inspector. If preparation is not satisfactory or if surface is contaminated, notify Architect in writing. Do not proceed with the installation before the deficiencies have been satisfactorily corrected.

C. Perform moisture testing per ASTM F1869 and F2170. Document results per this specification. If MVER or RH exceeds manufactures recommend level for specified product. Apply vapor control primer before proceeding.

D. Verify the substrate has proper levelness and flatness, or slope for drainage. If proper levelness and flatness, or slope for drainage is not in the substrate notify the Architect and General Contractor immediately. Do not proceed with flooring installation until the conditions are corrected.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to commencement of the preparation and installation.

B. Prepare surfaces using methods recommended by manufacturer for achieving best result for substrate under project conditions.

C. Concrete Surfaces: Shot-blast, or diamond grind per SSPC SP-13/NACE 6. Remove material to provide a sound surface free of laitance, glaze, efflorescence, bond inhibiting curing compounds or form release agents. Remove grease, oil, and other penetrating contaminates. Repair damaged and deteriorated concrete to acceptable condition per

ACI 546.R-04. Produce a surface profile equal to ICRI 310.25 CPS 2, CPS 3, or CPS 4. Leave surface free of dust, dirt, laitance, and efflorescence.

D. Underlayment for Slope and Drainage – Provide a trowel-grade underlayment as recommended and manufactured by the flooring manufacturer.

E. Cut 1/8” X 1/2” keyways around the perimeter, around drains, clean outs, access panels or other flooring interruption, and at expansion or isolation joints.

F. Apply Membrane in a 40 mil “neat” coat and allow to cure overnight. Apply a second 10 mil coat and broadcast with sand to rejection. Allow to cure.

G. Sweep off the surface and apply the Urethane Cement basecoat directly to the broadcast surface.

H. Verify proper surface profile per ICRI 310.25 CSP coupons. Perform water break test and tape dust cleanliness test per ISO 8502-3 to determine surface is acceptable to proceed.

3.3 INSTALLATION

A. Apply Flooring System components according to manufacturer's written instructions. Produce a uniform, monolithic wearing surface of thickness, color and texture indicated.

1. Coordinate application of components. Provide optimum adhesion of coatings to substrate, and optimum intercoat adhesion.
2. Cure coatings per manufacturer's written instructions. Prevent contamination during application and curing processes.
3. Expansion, Isolation and Control Joint Treatment: At substrate expansion, isolation and control joints, comply with resinous flooring manufacturer's written instructions.
4. Contractor shall keep daily logs recording the work performed and environmental conditions as required by the materials manufacturer.

B. Install 4” integral cove base with 5/8” radius at all vertical horizontal transitions.

C. Self-Leveling Body Coats: Apply in thickness indicated for flooring system.

1. Aggregates: Broadcast aggregates at rate recommended by manufacturer. After resin cures, remove excess aggregates.

D. Top Coat: Tek-Crete Sealer CP. Apply in number indicated for flooring system and at spreading rates recommended by manufacturer to produce wearing surface indicated.

3.4 CLEANING AND PROTECTION

A. Clean products after 96 hours cure in accordance with the manufacturer's recommendations.

B. Prohibit foot and wheel traffic over flooring for 24 hours. Light foot traffic is acceptable after 24 hours. Normal traffic after 48 hours.

C. Do not expose to harsh chemicals until full 7 days cure.

D. Touch-up, repair or replace damaged products before Substantial Completion

E. Provide floor protection acceptable to the materials manufacturer.

END OF SECTION

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SECTION 09 91 23 - INTERIOR PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes surface preparation and the application of paint systems on the following interior substrates:

1. Concrete.
2. Concrete masonry units (CMU).
3. Steel.
4. Galvanized metal.
5. Aluminum (not anodized or otherwise coated).
6. Wood.
7. Gypsum board.
8. Cotton or canvas insulation covering.

1.2 DEFINITIONS

A. Gloss Level 1: Not more than 5 units at 60 degrees and 10 units at 85 degrees, according to ASTM D 523.

B. Gloss Level 2: Not more than 10 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

C. Gloss Level 3: 10 to 25 units at 60 degrees and 10 to 35 units at 85 degrees, according to ASTM D 523.

D. Gloss Level 4: 20 to 35 units at 60 degrees and not less than 35 units at 85 degrees, according to ASTM D 523.

E. Gloss Level 5: 35 to 70 units at 60 degrees, according to ASTM D 523.

F. Gloss Level 6: 70 to 85 units at 60 degrees, according to ASTM D 523.

G. Gloss Level 7: More than 85 units at 60 degrees, according to ASTM D 523.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product. Include preparation requirements and application instructions.

1. Include Printout of current "MPI Approved Products List" for each product category specified, with the proposed product highlighted.
2. Indicate VOC content.

B. Samples: For each type of paint system and in each color and gloss of topcoat.

C. Product List: Cross-reference to paint system and locations of application areas. Use same designations indicated on Drawings and in schedules. Include color designations.

1.4 QUALITY ASSURANCE

A. Mockups: Apply mockups of each paint system indicated and each color and finish selected to verify preliminary selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Architect will select one surface to represent surfaces and conditions for application of each paint system specified in Part 3.

    a. Vertical and Horizontal Surfaces: Provide samples of at least 100 sq. ft..
    b. Other Items: Architect will designate items or areas required.

2. Final approval of color selections will be based on mockups.

    a. If preliminary color selections are not approved, apply additional mockups of additional colors selected by Architect at no added cost to Owner.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store materials not in use in tightly covered containers in well-ventilated areas with ambient temperatures continuously maintained at not less than 45 deg F.

1. Maintain containers in clean condition, free of foreign materials and residue.
2. Remove rags and waste from storage areas daily.

1.6 FIELD CONDITIONS

A. Apply paints only when temperature of surfaces to be painted and ambient air temperatures are between 50 and 95 deg F.

B. Do not apply paints when relative humidity exceeds 85 percent; at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Benjamin Moore & Co.
2. Coronado Paint; Benjamin Moore Company.
3. Frazee Paint; Comex Group.
4. Glidden Professional.
5. Kelly-Moore Paint Company Inc.
6. Kwal Paint; Comex Group.

7. Parker Paint; Comex Group.
8. PPG Architectural Finishes, Inc.
9. Pratt & Lambert.
10. Sherwin-Williams Company (The).

2.2 PAINT, GENERAL

A. MPI Standards: Provide products that comply with MPI standards indicated and that are listed in its "MPI Approved Products List."

B. Material Compatibility:

1. Provide materials for use within each paint system that are compatible with one another and substrates indicated, under conditions of service and application as demonstrated by manufacturer, based on testing and field experience.
2. For each coat in a paint system, provide products recommended in writing by manufacturers of topcoat for use in paint system and on substrate indicated.

C. VOC Content: Products shall comply with VOC limits of authorities having jurisdiction and, for interior paints and coatings applied at Project site, the following VOC limits, exclusive of colorants added to a tint base, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

1. Flat Paints and Coatings: 50 g/L.
2. Nonflat Paints and Coatings: 100 g/L.
3. Nonflat – High-gloss coatings: 150 g/L.
4. Dry-Fog Coatings: 150 g/L.
5. Primers, Sealers, and Undercoaters: 100 g/L.
6. Anticorrosive and Antirust Paints Applied to Ferrous Metals: 250 g/L.
7. Zinc-Rich Industrial Maintenance Primers: 340 g/L.
8. Pretreatment Wash Primers: 420 g/L.
9. Floor Coatings: 100 g/L.
10. Shellacs, Clear: 730 g/L.
11. Shellacs, Pigmented: 550 g/L.

D. Colors: As indicated in a color schedule on Drawings.

2.3 BLOCK FILLERS

A. Block Filler, Latex, Interior/Exterior: MPI #4.

2.4 PRIMERS/SEALERS

A. Primer Sealer, Latex, Interior: MPI #50.

B. Primer, Alkali Resistant, Water Based: MPI #3.

C. Primer Sealer, Interior, Institutional Low Odor/VOC: MPI #149.

D. Primer, Latex, for Interior Wood: MPI #39.

E. Wood-Knot Sealer: Sealer recommended in writing by topcoat manufacturer for use in paint systems indicated.

2.5 METAL PRIMERS

A. Primer, Rust-Inhibitive, Water Based: MPI #107.

B. Primer, Galvanized, Water Based: MPI #134.

C. Primer, Quick Dry, for Aluminum: MPI #95.

2.6 WATER-BASED PAINTS

A. Latex, Interior, Flat, (Gloss Level 1): MPI #53.

B. Latex, Interior, (Gloss Level 3): MPI #52.

C. Latex, Interior, (Gloss Level 4): MPI #43.

D. Latex, Interior, Semi-Gloss, (Gloss Level 5): MPI #54.

E. Latex, Interior, Gloss, (Gloss Level 6, except minimum gloss of 65 units at 60 degrees): MPI #114.

F. Latex, Interior, Institutional Low Odor/VOC, Flat (Gloss Level 1): MPI #143.

G. Latex, Interior, Institutional Low Odor/VOC, (Gloss Level 3): MPI #145.

H. Latex, Interior, Institutional Low Odor/VOC, Semi-Gloss (Gloss Level 5): MPI #147.

I. Latex, Interior, High Performance Architectural, (Gloss Level 4): MPI #140.

J. Latex, Interior, High Performance Architectural, Semi-Gloss (Gloss Level 5): MPI #141.

K. Light Industrial Coating, Interior, Water Based (Gloss Level 3): MPI #151.

L. Light Industrial Coating, Interior, Water Based, Semi-Gloss (Gloss Level 5): MPI #153.

2.7 TEXTURED COATING

A. Textured Coating, Latex, Flat: MPI #42.

2.8 DRY FOG/FALL COATINGS

A. Dry Fall, Latex, Flat: MPI #118.

B. Dry Fall, Water Based, for Galvanized Steel, Flat (Gloss Level 1): MPI #133.

2.9 FLOOR COATINGS

A. Stain, Interior, for Concrete Floors: MPI #58.

B. Floor Paint, Latex, Low Gloss (Maximum Gloss Level 3): MPI #60.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions, with Applicator present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

B. Maximum Moisture Content of Substrates: When measured with an electronic moisture meter as follows:

1. Concrete: 12 percent.
2. Masonry (Clay and CMU): 12 percent.
3. Wood: 15 percent.
4. Gypsum Board: 12 percent.

C. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

D. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Application of coating indicates acceptance of surfaces and conditions.

3.2 PREPARATION

A. Comply with manufacturer's written instructions and recommendations in "MPI Manual" applicable to substrates indicated.

B. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection if any.

C. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and reprime substrate with compatible primers or apply tie coat as required to produce paint systems indicated.

3.3 APPLICATION

A. Apply paints according to manufacturer's written instructions and to recommendations in "MPI Manual."

B. Apply paints to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks.

3.4 CLEANING AND PROTECTION

A. Protect work of other trades against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, as approved by Architect, and leave in an undamaged condition.

B. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.

3.5 INTERIOR PAINTING SCHEDULE

A. Concrete Substrates, Nontraffic Surfaces – MPI INT 3.1A:

1. Latex System – Eggshell Finish:

    a. Prime Coat: Primer, alkali resistant, water based, MPI #3.
    b. Intermediate Coat: Latex, interior, matching topcoat.
    c. Topcoat: Latex, interior, (Gloss Level 3), MPI #52.

2. Latex System – Semi-Gloss Finish:

    a. Prime Coat: Primer, alkali resistant, water based, MPI #3.
    b. Intermediate Coat: Latex, interior, matching topcoat.
    c. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5), MPI #54.

B. Concrete Substrates, Traffic Surfaces – MPI INT 3.2A:

1. Latex Floor Enamel System:

    a. Prime Coat: Floor paint, latex, low gloss (maximum Gloss Level 3), MPI #60.
    b. Intermediate Coat: Floor paint, latex, low gloss (maximum Gloss Level 3), MPI #60.
    c. Topcoat: Floor paint, latex, low gloss (maximum Gloss Level 3), MPI #60.

2. Concrete Stain System:

    a. First Coat: Stain, interior, for concrete floors, MPI #58.
    b. Topcoat: Stain, interior, for concrete floors, MPI #58.

C. Concrete Substrates, Deck or Ceiling Above – MPI INT 3.1N

1. Latex Aggregate System – Flat Finish:

    a. Prime Coat: As recommended in writing by topcoat manufacturer.
    b. Intermediate Coat: As recommended in writing by topcoat manufacturer.
    c. Topcoat: Textured coating, latex, flat, MPI #42.

D. CMU Substrates – MPI INT 4.2A:

1. Latex System – Eggshell Finish:

    a. Block Filler: Block filler, latex, interior/exterior, MPI #4.
    b. Intermediate Coat: Latex, interior, matching topcoat.
    c. Topcoat: Latex, interior, (Gloss Level 3), MPI #52.

2. Latex System – Semi-Gloss Finish:

    a. Block Filler: Block filler, latex, interior/exterior, MPI #4.
    b. Intermediate Coat: Latex, interior, matching topcoat.
    c. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5), MPI #54.

E. Steel Substrates, Hollow Metal Doors & Frames – MPIP INT 5.1B:

1. Water-Based Light Industrial Coating System – Eggshell Finish:

    a. Prime Coat: Primer, rust-inhibitive, water based MPI #107.
    b. Intermediate Coat: Light industrial coating, interior, water based, matching topcoat.
    c. Topcoat: Light industrial coating, interior, water based (Gloss Level 3), MPI #151.

2. Water-Based Light Industrial Coating System – Semi-Gloss Finish:

    a. Prime Coat: Primer, rust-inhibitive, water based MPI #107.
    b. Intermediate Coat: Light industrial coating, interior, water based, matching topcoat.
    c. Topcoat: Light industrial coating, interior, water based, semi-gloss (Gloss Level 5), MPI #153.

F. Steel Substrates, Metal Deck Above – MPI INT 5.1C:

1. Water-Based Dry-Fall System:

    a. Prime Coat: Shop primer specified in Section where substrate is specified.
    b. Topcoat for Shop Primed or Previously Painted Steel: Dry fall, latex, flat, MPI #118.

G. Steel Substrates, Other – MPI INT 5.1R:

1. High-Performance Architectural Latex System – Semi-Gloss:

    a. Prime Coat: Shop primer specified in Section where substrate is specified.

b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
c. Topcoat: Latex, interior, high performance architectural, (Gloss Level 4), MPI #140.

2. High-Performance Architectural Latex System – Gloss:

a. Prime Coat: Shop primer specified in Section where substrate is specified.
b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
c. Topcoat: Latex, interior, high performance architectural, semi-gloss (Gloss Level 5), MPI #141.

H. Galvanized-Metal Substrates, Hollow Metal Doors & Frames – MPI INT 5.3K:

1. Water-Based Light Industrial Coating Over Waterborne Primer System – Eggshell Finish:

a. Prime Coat: Primer, galvanized, water based, MPI #134.
b. Intermediate Coat: Light industrial coating, interior, water based, matching topcoat.
c. Topcoat: Light industrial coating, interior, water based (Gloss Level 3), MPI #151.

2. Water-Based Light Industrial Coating Over Waterborne Primer System – Semi-Gloss Finish:

a. Prime Coat: Primer, galvanized, water based, MPI #134.
b. Intermediate Coat: Light industrial coating, interior, water based, matching topcoat.
c. Topcoat: Light industrial coating, interior, water based, semi-gloss (Gloss Level 5), MPI #153.

I. Galvanized-Metal Substrates, Metal Deck Above – MPI 5.3H:

1. Water-Based Dry-Fall System:

a. Prime Coat: Dry fall, water based, for galvanized steel, flat (Gloss Level 1), MPI #133.
b. Topcoat: Dry fall, water based, for galvanized steel, flat (Gloss Level 1), MPI #133.

J. Galvanized-Metal Substrates, Other – MPI INT 5.3M:

1. High-Performance Architectural Latex System – Semi-Gloss:

a. Prime Coat: Primer, galvanized, water based, MPI #134.
b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.

c. Topcoat: Latex, interior, high performance architectural, (Gloss Level 4), MPI #140.

2. High-Performance Architectural Latex System – Gloss:

a. Prime Coat: Primer, galvanized, water based, MPI #134.
b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
c. Topcoat: Latex, interior, high performance architectural, semi-gloss (Gloss Level 5), MPI #141.

K. Aluminum (Not Anodized or Otherwise Coated) Substrates – MPI INT 5.4F:

1. High-Performance Architectural Latex System – Semi-Gloss:

a. Prime Coat: Primer, quick dry, for aluminum, MPI #95.
b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
c. Topcoat: Latex, interior, high performance architectural, (Gloss Level 4), MPI #140.

2. High-Performance Architectural Latex System – Gloss:

a. Prime Coat: Primer, quick dry, for aluminum, MPI #95.
b. Intermediate Coat: Latex, interior, high performance architectural, matching topcoat.
c. Topcoat: Latex, interior, high performance architectural, semi-gloss (Gloss Level 5), MPI #141.

L. Wood Substrates: Including wood trim, architectural woodwork, doors, and wood-based panel products – MPI INT 6.3T:

1. Latex System – Satin Finish:

a. Prime Coat: Primer, latex, for interior wood, MPI #39.
b. Intermediate Coat: Latex, interior, matching topcoat.
c. Topcoat: Latex, interior, (Gloss Level 4), MPI #43.

2. Latex System – Semi-Gloss Finish:

a. Prime Coat: Primer, latex, for interior wood, MPI #39.
b. Intermediate Coat: Latex, interior, matching topcoat.
c. Topcoat: Latex, interior, semi-gloss, (Gloss Level 5), MPI #54.

3. Latex System – Gloss Finish:

a. Prime Coat: Primer, latex, for interior wood, MPI #39.
b. Intermediate Coat: Latex, interior, matching topcoat.
c. Topcoat: Latex, interior, gloss, (Gloss Level 6, except minimum gloss of 65 units at 60 degrees), MPI #114.

M. Gypsum Board Substrates, Walls & Ceilings – MPI INT 9.2M:

1. Institutional Low-Odor/VOC Latex System – Flat Finish:

   a. Prime Coat: Primer sealer, interior, institutional low odor/VOC, MPI #149.
   b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
   c. Topcoat: Latex, interior, institutional low odor/VOC, flat (Gloss Level 1), MPI #143.

2. Institutional Low-Odor/VOC Latex System – Eggshell Finish:

   a. Prime Coat: Primer sealer, interior, institutional low odor/VOC, MPI #149.
   b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
   c. Topcoat: Latex, interior, institutional low odor/VOC, (Gloss Level 3), MPI #145.

3. Institutional Low-Odor/VOC Latex System – Semi-Gloss Finish:

   a. Prime Coat: Primer sealer, interior, institutional low odor/VOC, MPI #149.
   b. Intermediate Coat: Latex, interior, institutional low odor/VOC, matching topcoat.
   c. Topcoat: Latex, interior, institutional low odor/VOC, semi-gloss (Gloss Level 5), MPI #147.

N. Cotton or Canvas Insulation-Covering Substrates: Including pipe and duct coverings – MPI INT 10.1A:

1. Latex System – Flat:

   a. Prime Coat: Primer sealer, latex, interior, MPI #50.
   b. Intermediate Coat: Latex, interior, matching topcoat.
   c. Topcoat: Latex, interior, flat (MPI Gloss Level 1), MPI #53.

END OF SECTION

SECTION 10 44 16 - FIRE EXTINGUISHERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes portable, hand-carried fire extinguishers and mounting brackets for fire extinguishers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.4 COORDINATION

A. Coordinate type and capacity of fire extinguishers with fire-protection cabinets to ensure fit and function.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.

2.2 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS

A. Fire Extinguishers: Type, size, and capacity for each fire-protection cabinet or mounting bracket indicated.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ansul Incorporated.
b. Badger Fire Protection.
c. JL Industries, Inc.; a division of the Activar Construction Products Group.
d. Larsens Manufacturing Company.
e. Nystrom Building Products.
f. Potter Roemer LLC.

2. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.

B. Multipurpose Dry-Chemical Type: UL-rated 4-A:80-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container.

2.3 MOUNTING BRACKETS

A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or black baked-enamel finish.

B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.

1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.

a. Orientation: Vertical.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Examine fire extinguishers for proper charging and tagging.

1. Remove and replace damaged, defective, or undercharged fire extinguishers.

B. Install fire extinguishers in locations indicated or, if not indicated, at a minimum rate of one fire extinguisher for each 6,000 sq. ft. of floor area or fraction thereof.

C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

1. Mounting Height: 54 inches above finished floor to top of fire extinguisher.

END OF SECTION

SECTION 22 45 00 - EMERGENCY PLUMBING FIXTURES, PEDESTAL-MOUNTED

PART 1 - GENERAL

1.1 SECTION INCLUDES

1. Pedestal-mounted eye/face wash equipment.
2. Water-tempering equipment.
3. Emergency signaling systems.

1.2 RELATED SECTIONS

A. Division 22 Section "Domestic Water Piping" for tempered water piping.

B. Division 22 Section "Sanitary Waste Piping Specialties" for floor drains.

C. Division 26 sections for electrical power and control wiring.

1.3 REFERENCES

A. American National Standards Institute (ANSI):

1. ANSI Z 358.1 – American National Standard for Emergency Eyewash and Shower Equipment.

B. US Federal Government:

1. Public Law 90-480 – The Architectural Barriers Act of 1968, as amended.
2. Public Law 101-336 – The Americans with Disabilities Act of 1990, as amended.

1.4 ACTION SUBMITTALS

A. Product Data: For each product:

1. Manufacturer's data sheets indicating operating characteristics, materials and finishes.
2. Include details of electrical and mechanical operating parts.
3. Provide mounting requirements and rough-in dimensions.
4. Mark each sheet with product drawing designation.

B. Shop Drawings: Submit power, signal, and control wiring diagrams.

1.5 INFORMATION SUBMITTALS

A. Manufacturer's Certificates: Submit certificates documenting factory testing of specified units.

C. Field quality-control test reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.7 MAINTENANCE SUBMITTALS

A. Furnish indicated spare parts that are packaged with identifying labels listing associated products.

1.8 QUALITY ASSURANCE

A. Source Limitations: Obtain emergency plumbing fixtures through a single source from a single manufacturer.

A. ANSI Standard: Classifed by UL to comply with ANSI Z358.1.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. EN Standard: Comply with EN 15154-2.

D. NSF Standard: Comply with NSF 61 for fixture components in contact with potable water.

E. Accessibility Requirements: Comply with ICC/ANSI A117.1; and requirements of authorities having jurisdiction.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide GUARDIAN G1760HFC.
   a. Substitutions: Submit in accordance with requirements of Division 01.

2.2 EMERGENCY PLUMBING FIXTURES, GENERAL

A. Eyewash and Eye/Facewash Units: Integral flow control at 5.1 gpm (19.1L/m) with steady water flow under varying water supply conditions from 30 to 90 psi; self-draining bowl with integral strainer; ergonomic stainless steel paddle operated unless otherwise indicated.

1. Supply piping 1/2-inch NPT with stay-open ball valve.
2. Drain piping 1-1/4-inch NPT.

2.3 PEDESTAL-MOUNTED EMERGENCY PLUMBING FIXTURES

A. Pedestal-Mounted, Emergency Eyewash Stations: With separate supply and waste piping. Provide factory-assembled and tested units with standard-compliant identification sign and inspection tag.

1. Model: GUARDIAN G1760HFC.
2. Model Description: Eye/Facewash with polished 304 stainless steel sprayhead with flip-open dust covers; 304 stainless steel bowl; 304 stainless steel piping; 316 stainless steel ball valve; push paddle activated.

2.4 WATER TEMPERING EQUIPMENT

A. Thermostatic Mixing Valve for Eyewash, Eye/Face Wash, and Drench Shower Fixture Units: ANSI Z358.1 compliant single valve design with liquid-filled unit-mounted dial thermometer, providing 85 deg F (29 deg C) tepid, potable water, maintaining temperature at plus or minus 3 deg F for required 15-minute test period, and with automatic shutoff in case of unit failure to continue cold-water flow, with associated corrosion-resistant housing and fittings.

1. Basis of Design Manufacturer/Model: Bradley, Navigator S19-2000 (EFX8).
2. Model Description: Emergency fixture thermostaticmixing valve for eyewash and eye/facewash units: 7 gpm at 30 psi
3. Supply Connections: Hot and cold water.
4. Finish: Rough bronze.
5. Cabinet:
    a. Mounting: Recessed.
    b. Material and Finish: Satin finish stainless steel.
    c. Door: Cylinder door lock.

2.5 EMERGENCY FIXTURE SIGNALING SYSTEMS

A. Automatic Audible and Visual Signaling System: Signaling system intended to alert others that the emergency fixture has been activated with flow switch.

1. Basis of Design Manufacturer/Model: Bradley, S19-322E.
2. Description: Solid state signaling system for eyewash or eye/facewash emergency fixtures; 85dB horn, green/amber LED beacon, and double pole, double throw brass flow switch 1/2 inch NPT, 24VDC; remote building management system compatible; recessed NEMA 1 General Purpose interior use enclosure for electrical components
3. Electrical: 90-260 VAC, 15W.

2.6 EMERGENCY FIXTURE ACCESSORIES

A. Drench Hose: 8-foot (2438 mm) yellow reinforced thermoplastic hose. Operating range 30-90 psi and flow rate of 2.4-2.8 gpm. 3/8-inch NPT male thread, with chrome-plated brass stay- open valve, with vacuum breaker with backflow preventer, attachment supply, fittings, and hangar, equipped with ABS plastic spray head and cover.

B. Extreme Condition Protection: Scald Protection Valve.

2.7 MATERIALS

A. Stainless Steel: ASTM A 666 Type 304.

B. Stainless Steel: ASTM A 666 Type 316.

C. Steel Sheet: ASTM A 1008/A 1008M, Designation CS, manufacturer's standard thickness.

D. Galvanized-Steel Sheet: ASTM A 653/A 653M, with G60 hot-dip zinc coating, manufacturer's standard thickness.

E. Galvanized-Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.

F. Fasteners:

1. Exposed: Screws, bolts, and other devices of same material as accessory unit and tamper-and-theft resistant.
2. Concealed: Galvanized steel.

G. Chrome Plating: ASTM B 456, Service Condition Number SC 2, moderate service.

H. ABS Plastic: Acrylonitrile-butadiene-styrene resin formulation, impact resistant.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Assemble fixtures and associated fittings and trim in accordance with manufacturer's instructions.

B. Install fixture supports attached to building structure for fixtures requiring supports.

C. Install fixtures onto waste-fitting seals or flanges and attach to supports or building structure.

D. Install fixtures level, plumb, and firmly in place in accordance with manufacturer's rough-in drawings.

E. Install water supply piping to each fixture requiring water supply connection. Provide stop on each supply in readily-serviced location. Fasten supply piping to supports or substrate.

F. Install trap and waste piping to each fixture requiring sanitary system connection.

G. Install escutcheons at exposed piping penetrations in finished locations and within cabinets.

H. Seal joints between fixtures and walls, floors, and countertops with mildew-resistant silicone sealant.

3.2 CLEANING AND PROTECTION

A. Repair or replace defective work, including damaged fixtures and components.

B. Clean unit surfaces, test fixtures, and leave in ready-to-use condition.

C. Turn over keys, tools, maintenance instructions, and maintenance stock to Owner.

D. Protect units with water-resistant temporary covering. Do not allow temporary use of plumbing fixtures unless approved in writing by Architect. Remove protection at Substantial Completion and dispose.

3.3 TESTING AND ADJUSTING

A. Set field-adjustable temperature set points of temperature-actuated water mixing valves. Adjust set point within allowable temperature range.

B. Test and adjust installation.

C. Remove and replace malfunctioning thermostatic mixing valves and retest.

END OF SECTION

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SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 CONTRACT DOCUMENTS

A. Comply with Contract Documents: All Work of this Section shall comply with the requirements of the Conditions of the Contract (General, Supplementary and Special), with all Sections of Division 1 - General Requirements, with this Section of the Specifications, with the Drawings and with all other Contract Documents.

B. Flammable Materials or materials not conforming in all respects to the fire resistive and fire safety provisions of governing regulations shall not be left in place in the Work.

C. Disposition of and Exposure to Materials: Contractor remains fully responsible for the disposition and the exposure to persons of all materials, whether or not hazardous.

D. Volatile Organic Compounds (VOC): Contractor remains fully responsible for the supplying of products and materials complying to the VOC limitations set forth by the *Building Code* and by governing agencies having jurisdiction.

1.2 WORK INCLUDED

A. Scope: Contractor shall examine all of the Contract Documents for the extent of the Work of this Section of the Specifications. That Work shall include all labor, materials, devices, plants, tools, equipment, appliances and services necessary to complete the Work as shown in the Drawings, as specified herein, as required by job conditions, and as required by governing authorities having jurisdiction, including but not limited to the following:

1. Designing and testing of concrete mixes. Designing of concrete mixes shall be by Contractor's Professional Engineer licensed in the project's jurisdiction.
2. Submission of Shop Drawings, samples, supporting data, mill certificates and the like.
3. Furnishing, fabricating and placing of all reinforcing bars, mesh, field-applied concrete anchors, metal and plastic accessories, spacers and the like.
4. Cooperation in the making of concrete testing samples, in inspecting reinforcing steel and in all other activities related to Work of this Section.
5. Footings, pile caps grade beams, walls, pilasters, and the like.
6. Porous fill and vapor barrier under slabs on ground.
7. Slabs at ground including trenches and equipment bases and the like.
8. Encasement of electrical conduits, ducts and the like.
9. Keys in construction joints.
10. Grouting and concrete encasement of beam and column base plates and of grillages.

11. Concrete bases and "housekeeping" pads.
12. Concrete fills and topping slabs, where shown in Architectural or Structural Drawings.
13. Grouting, setting and building-in of embedded items provided under other Sections of this Specification.
14. Providing expansion, control and construction joints in concrete Work including the surface preparation and application of bonding compound where specified.
15. Forming and bracing of concrete Work, including both shoring and reshoring of formwork and concrete, and the subsequent removal of formwork, bracing and the like. Design of formwork shall be by Contractor's Professional Engineer licensed in the project's jurisdiction.
16. Formwork for pockets, chases, slots, reglets, depressions and openings in concrete Work required for the installation of Work specified under other Sections of this Specification.
17. Filling, patching and rubbing concrete exposed to view in finished Work.
18. Finishing, curing, and protection of all concrete Work, including both hot and cold weather protection of concrete Work.
19. Hardening and dustproofing of exposed, interior concrete floors, platforms, stairs, landings and the like, including surfaces to receive carpeting and other finishes.
20. Cleaning of concrete exposed to view and where required to receive other materials.
21. Furnishing and placing concrete where concrete Work is delayed to accept hoists, block-outs and other Work associated with Contractor's means and methods of construction.
22. Reinforced concrete fireproofing with related anchors and reinforcement, of structural steel columns, beams, girders and the like at all locations where structural steel is shown to be fireproofed with concrete.
23. Provisions for other Work.
24. Cooperate with Owner, with Construction Manager, with Architect and with Testing Agency in all aspects of quality assurance and in all other activities related to the work of this Section.
25. The safe handling and disposition of materials related to the Work of this Section, whether or not hazardous.
26. All other labor, materials and Work given in the Drawings, specified herein or required to make the Work complete.

B. Work Installed as Specified Elsewhere: Contractor shall examine all of the Contract Documents for the extent of Work to be installed under this Section. Such work shall include, but shall not be limited to:

1. Anchor bolts, inserts and other embedded items for walls, partitions, window, curtain wall, precast concrete, stonework, veneers and the like.
2. Angle edging, corner guards, curb edging and the like at platforms and columns and the like.
3. Provision for and cooperation work of other trades for the passage through concrete Work of gas, oil, storm, sewer, water, telephone and other communication systems, electrical, sprinkler, HVAC and other service lines and ducts.
4. Sleeves for penetration through concrete.

5. Provisions for electrical and lightning grounding.
6. Embedded items of other trades similar to the items listed in this Article.

1.3 RELATED WORK

A. Related Work Specified Elsewhere, Amplified Elsewhere or Included in Other Contracts:

1. Submittals: Section 01 30 00.
2. Owner's plant and field testing and inspection of concrete Work by Testing Agency engaged and paid for by Owner: Section 01 40 00.
3. Masonry: Division 4.
4. Structural Steel: Section 05 10 00.
5. Metal Deck: Section 05 30 00.
6. Miscellaneous Metals: Section 05 50 00.
7. Architectural Metals: Section 05 70 00.
8. Decorative Metal and Glass Railings: Section 05 73 00.
9. Fluid-Applied Roofing and Waterproofing: Section 07 54 00.
10. Flashings and Sheet Metal: Section 07 60 00.
11. Sealants: Section 07 90 00.
12. Curtain Wall: Section 08 44 11.
13. Special Coatings: Section 09 80 00.
14. Painting: Section 09 90 00.
15. Plumbing, Fire Protection Systems and Heating, Ventilating, Air-Conditioning: Divisions 22 and 23.
16. Electrical: Division 26.
17. Furnishing of embedded items required by and specified under other Sections of this Specification.
18. Other items similar to the items listed in this Article.

1.4 APPLICABLE CODES AND STANDARDS

A. General: Except as modified or voided by requirements specified herein or by details or notes included in the Drawings, Work specified under this Section shall conform to all applicable provisions of the codes, specifications, standards and other reference documents cited in this Specification and/or noted in the Drawings. In the event of conflict between provisions of stipulated reference documents and of this Specification or of another stipulated reference document, Contractor shall report in writing the details of the conflict. Decisions regarding applicability of provisions of this Specification and provisions of reference documents applied independently or as supplemented, modified or voided, will be provided in writing and shall be final. Resolution of conflicts shall conform to the procedures set forth in the General Conditions of the Contract.

B. Codes: All Work under this Section shall conform to the requirements of the 2022 Connecticut State Building Code, hereinafter referred to as *Building Code*, and to the regulations of all governmental authorities having jurisdiction. Where more stringent, the following codes, standards, manuals and specifications, latest edition and revision, shall apply to the Work, all as modified herein or by *Building Code*:

1. *Standard Specification for Tolerances for Concrete Construction and Materials*, ACI 117.
2. *Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete*, ACI 211.1.
3. *Recommended Practice for Evaluation of Strength Test Results of Concrete*, ACI 214.
4. *Field Reference Manual: Specifications for Structural Concrete, ACI 301, with Selected ACI and ASTM References*, SP-l5.
5. *Guide for Measuring, Mixing, Transporting and Placing Concrete*, ACI 304.
6. *Building Code Requirements for Structural Concrete*, ACI 318 and Commentary, ACI 318R. (referred to hereinafter as ACI Code).
7. *Standard Specification for Cold Weather Concreting*, ACI 306.1.
8. *Standard Practice for Curing Concrete*, ACI 308.
9. *Guide for Consolidation of Concrete*, ACI 309.
10. *Structural Welding Code - Steel*, ANSI/AWS D1.1.
11. *Structural Welding Code - Reinforcing Steel*, ANSI/AWS D1.4.
12. *National Design Specification for Wood Construction*, National Forest Products Association.

C. Reference Documents: To the extent that the best quality of Work is provided, Work shall conform to the examples, procedures and recommendations listed below, latest edition and revision. Where provisions of the *Building Code*, this Specification, or codes, standards, manuals and specifications cited by this Specification are more restrictive or provide increased quality, the combination of provisions, examples, procedures and recommendations which provide both best quality and *Building Code* conformance shall control the Work.

1. *ACI Detailing Manual*, SP-66 (Includes ACI 315 and ACI 315R). Note that some aspects of SP-66 are out-of-date (bar development lengths, etc.)
2. ACI Concrete Terminology, ACI CT-13.
3. *Chemical Admixtures for Concrete*, ACI 212.3R.
4. *Guide for the Use of High-Range Water-Reducing Admixtures (Superplasticizers) in Concrete*, ACI 212.4R.
5. *Guide for Use of Normal Weight Aggregates in Concrete*, ACI 221R.
6. *Use of Fly Ash in Concrete*, ACI 226.3R.
7. *Guide for Concrete Floor and Slab Construction*, ACI 302.1R.
8. *Placing Concrete by Pumping Methods*, ACI 304.2R.
9. *Hot Weather Concreting*, ACI 305R.
10. *Cold Weather Concreting*, ACI 306R.
11. *Guide for Consolidation of Concrete*, ACI 309R.

12. *Guide to Formwork for Concrete*, ACI 347R with the specific deletion of reference to tolerances where in conflict with this Specification. Tolerances given in ACI 117 shall apply to the Work except where less stringent than are provided under this Specification.
13. *Manual of Standard Practice*, Concrete Reinforcing Steel Institute.
14. *Mechanical Connections of Reinforcing Bars*, ACI 439.3R.
15. *Use of Epoxy Compounds with Concrete*, ACI 503R.
16. *Guide for the Selection of Polymer Adhesives with Concrete*, ACI 503.5R.
17. *Guide to Durable Concrete*, ACI 201.2R.
18. *Protection of Metals in Concrete Against Corrosion*, ACI 222R.
19. *Qualification of Post-Installed Mechanical Anchors in Concrete*, ACI 355.2.
20. *Qualification of Post-Installed Adhesive Anchors in Concrete*, ACI 355.4.

D. ASTM (American Society for Testing and Materials) Specifications cited in ACI 318, ACI 301, this Specification or in cited reference documents shall be the year of adoption or tentative adoption and revision listed in the latest edition of the Annual Book of ASTM Standards, *Index*, except that, should a specific year of adoption or revision be cited by the Contract Documents, by *Building Code*, or be proposed by Contractor and be accepted by Structural Engineer, that edition shall apply to and shall control the Work.

E. Conformance to Regulations: Work of this Section shall conform to all applicable federal, state, and local laws and regulations.

1.5 SUBMITTALS

A. General: Submit samples, Shop Drawings, product data, test reports and data, manufacturer's names, certifications, procedures, methodology statements, and the like as stipulated. With the exception of samples, submittals shall be in PDF format and transmitted electronically, unless otherwise accepted.

1. Review of Contractor's submittals is only for the limited purpose of the examination of submittals for conformance with the design concept of the project and to assist Contractor in ascertaining that the information given in the submittals conforms to the requirements of the Contract Documents.
2. Review of Contractor's submittals is not conducted for the purpose of determining the accuracy or the completeness of the submittal, for dimensions or quantities, or for installation or performance of the system or the piece(s) being submitted.
3. Submittals by Contractor implies that Contractor has checked the submittal with care. Where by error or other cause, Contractor's check has not been accomplished, Contractor shall not rely on review but shall first check and shall then resubmit such material as though the submittal had been rejected.

B. Samples: Submit for acceptance prior to purchase, fabrication or delivery:

1. Miscellaneous Inserts; each type.
2. Joint Filler; 12" (300 mm) long.
3. Post-Installed Anchors; each type.

4. One each of mechanical connections, for each size of bar to be spliced, complete with bars extending approximately 4" (100 mm) beyond the ends of the splice.
5. Dowel and rectangular load plate basket assemblies at slab on ground contraction joints.
6. Diamond-shape load plates at slab on ground construction joints.
7. Substitute Products, Materials and Fixtures, where requested by Contractor, shall be accompanied by sample(s) of an acceptable size.
8. Other Products, Materials and Fixtures, as specified herein and where requested in writing.

C. Shop Drawings:

1. General: Shop Drawings, as the term is used under this Section, are not Contract Documents, but are intended to demonstrate the way that Contractor intends to conform to the requirements provided in the Contract Documents. Contractor may wish to use these same drawings as a part of the instructions given to craftpersons for the accomplishment of the Work.
2. Best Standards: Shop Drawings furnished under this Section shall conform to the best standards of the construction industry. Shop Drawings shall be prepared by and under the supervision of competent engineering personnel.
a) Shop Drawings shall be prepared under the direction of personnel completely familiar with Architectural, Mechanical, Plumbing, Electrical and other building trades Drawings.
b) Comply with the requirements of ACI SP-66 where more stringent than is specified herein. Show bar schedules; stirrup size and spacing, drawings of bent bars, and size and arrangement of all reinforcement
3. Shop Drawings shall be submitted for review and to governing agencies having jurisdiction for acceptance in accordance with the provisions of the Contract Documents.
4. Shop Drawings shall be submitted in parts as follows:
a) Sleeve, Insert and Fitting Location Drawings,
b) Construction Joint and Crack Control Joint Location and Detail Drawings,
c) Formwork Drawings,
d) Placing Plans and Elevations,
e) Detail Drawings and Schedules,
f) As required for the work of other trades,
g) Field Work Drawings
5. Sleeve, Insert and Fitting Location Drawings shall show clearly the location and orientation of each item to be placed into the formwork. Include items for the Work of other trades such as elevators, dock levelers, plumbing and sprinkler systems, HVAC, electrical and the like.
6. Construction Joint and Crack Control Joint Drawings shall show the location of joints in beams, slabs, walls and the like, and shall show also the sequence of pours and all else needed for the proper detailing of reinforcing steel. Show and detail keys and the like. Indicate extent and type of bonding compound. Submit in sufficient time to allow the orderly detailing of reinforcing steel.

7. Formwork Drawings shall include plans, elevations, sections and complete details to describe clearly, at an ample scale, all Work to be provided. Drawings shall be dimensioned accurately, where applicable, and shall be notated clearly. Detail ledges, curbs, pads, trenches, openings and the like from information given in Architectural, Structural, HVAC, Plumbing, Electrical and other Contract Documents.

a) Show in the Formwork Drawings and dimension thereon, holes required for passage of Work of other Divisions and other Sections of this Specification through Cast-In-Place Concrete Work.

b) Contractor's Professional Engineer licensed in the project's jurisdiction shall be responsible for the design of formwork. As evidence of conformance with this requirement, each Formwork Drawing shall bear the seal and signature of Contractor's Professional Engineer.

8. Placing Plans and Elevations shall show, to scale with all dimensions, all concrete Work including top of slabs and depressions, pits, curbs, trenches, pads, equipment bases, steps, slopes, radii, curves, edges of slabs, openings, sleeves, blockouts and the like. Provide schedules and details showing placing sequences, bending, lengths and locations of all reinforcement. Show elevations of all concrete walls with top and bottom elevations, openings, ledges, pockets, construction joints, and all else needed to locate correctly all reinforcement. Detail top and bottom layers of two-way slab reinforcement on separate plans. Identify all epoxy-coated and galvanized reinforcement. Indicate all lap lengths and lap locations in the placing plans.

a) Detailing of Reinforcing Steel shall recognize the arrangement and dimensioning of individual bars, including the location of bend points, hooks and the like so as to preclude interference between bars, sets of bars, and embedded items and so as to allow clear spacing and concrete cover as provided in ACI 315 and ACI 318. Prepare details and provide sections showing placement sequences to minimize congestion of reinforcing steel at splices, intersecting bars around openings and block-outs, and adjacent to embedded items. Illustrate and note correct placing arrangement and placing sequence to enable field placing crews to properly place and execute the Work. Provide sections, typical details and notes to illustrate correct location and arrangement of and clear cover for reinforcement and required placement locations. Provide suitable and necessary details and placing sequence information in Shop Drawings so as to properly instruct reinforcing steel placement personnel.

9. Detail Drawings and Schedules for reinforcing steel, including welded wire fabric (WWF), shall be prepared in strict accord with the methods and procedures provided in ACI SP-66 except that provisions of the Drawings and of this Specification shall prevail. Detail Drawings shall include bar and fabric lists; applicable bar lists shall be submitted simultaneously with related Detail Drawings. Prepare Detail Drawings which provide for reinforcement, including dowels, properly positioned in all concrete Work, so that material can be properly cut, bent and packaged from information given in Detail Drawings.

a) Reinforcement for concrete Work shall include all reinforcement shown or scheduled in Drawings, including all reinforcement required by typical details and general notes. Provide minimum percentages of reinforcing steel required by ACI Code where such reinforcement exceeds that stipulated in Drawings.
b) Reinforcement shall be spliced in strict accord with ACI 318. Where practical, stagger splices of adjacent bars.
c) Unless shown specifically to the contrary, all reinforcement shall be spliced and all splices shall develop the full tensile capacity of the reinforcement. No reduction in splice length or development requirements may be taken because supplied reinforcing is larger than that required under the Contract.
d) Lapped bars may be detailed to be placed in contact and securely wired together or may be separated in accord with ACI 318 to permit embedment of the entire surface of each bar in concrete.
e) Extend slab, beam and girder reinforcement to the far face of supports except where lesser embedment is provided explicitly in the Drawings.

10. Requirements for the Work of Other Trades: Submit detailed drawings showing requirements for the passage of reinforcement through structural steel, precast concrete, masonry and the like.

11. Field Work Drawings: Prepare Field Work Drawings depicting all field work required to accommodate field conditions.

12. Contractor shall coordinate and cross-check for accuracy, completeness and correct relationship to the Work of other Sections, each Shop Drawing prepared for the Work of this Section, including each Shop Drawing prepared by accepted subcontractors. Pay particular attention to areas of congestion of reinforcement and to areas where reinforcement and other embedded items combine to cause congestion. Contractor's check shall include a verification of compliance with the Contract Documents and shall be performed prior to submission and resubmission of each Shop Drawing. The personally inscribed initials of the person(s) preparing each shop drawing as well as the detailing agency's supervisor and chief checker shall be included in the title block or similarly prominent location.

13. Substitutions: Should Contractor desire a Substitution or Deviation from the Drawings or Specifications, or both, Contractor shall submit the specific request in writing prior to the submittal of Shop Drawings showing the Substitution or Deviation. Requests for Substitutions or Deviations shall be submitted on Contractor's letterhead. Substitutions and Deviations not identified, or identified only in letters of transmittal or in Shop Drawings, or both, without the required written description on Contractor's letterhead, may not be accepted and shall be sufficient cause for the rejection and the return of such Shop Drawings without further action.

a) Acceptance of Shop Drawings including Substitutions and Deviations not detected during Shop Drawing review, shall not relieve Contractor from responsibility to conform strictly to the Contract Documents. Substitutions and deviations will be allowed only where permitted in writing.

14. Shop Drawing Review: Only Shop Drawings marked "No Exceptions Taken" or "Make Corrections Noted - Resubmission Not Required" may be used by Contractor in the Work. Shop Drawings marked "Make Corrections Noted - Resubmit" shall be corrected or completed (or both) as required and shall be resubmitted. This process shall be repeated the number of times required to achieve the mark "No Exceptions Taken" or "Make Corrections Noted - Resubmission Not Required". An example of Structural Engineer's Shop Drawing review stamp is shown here for reference.

STRUCTURAL ENGINEER REVIEW

NO EXCEPTIONS TAKEN ☐ RESUBMISSION NOT REQUIRED ☐
MAKE CORRECTIONS NOTED ☐ RESUBMIT ☐
NOT REVIEWED ☐

LESLIE E. ROBERTSON ASSOCIATES

BY: _____

DATE: _____

a) Nonconformities and errors detected during review will be noted in Shop Drawings returned to Contractor upon completion of review. Acceptance of Shop Drawings including Substitutions and Deviations not detected during review will not relieve Contractor from sole responsibility to provide Work conforming strictly to the Contract Documents.
b) Shop Drawing review includes engineering calculations only to the extent deemed necessary to ascertain that Contractor's Shop Drawings have been prepared by competent personnel. Contractor alone is responsible for the accuracy and the completeness of Contractor's engineering calculations.
c) Review of Contractor's Shop Drawings does not include a review of bills of materials and the like. Accordingly, information required for the review of Shop Drawings shall be contained outside of bills of materials and the like.

15. Resubmission of Shop Drawings: Prior to resubmission of Shop Drawings with additions, deletions, or corrections, Contractor shall cloud and identify all changes from the prior issue. Drawings submitted without each change both clouded and identified clearly will be returned and shall be resubmitted as though the original submittal had been rejected. Each submittal, whether or not accepted or rejected, shall contain a unique revision number, clearly identified.

16. Shop Drawing Log: Contractor shall number Shop Drawings, and revisions to Shop Drawings, in a form acceptable both to Contractor and to Architect/Structural Engineer. Structural Engineer will provide to Contractor in its letters of transmittal both the log-in and the log-out date of each Shop Drawing. Further, on request of Contractor, Structural Engineer will provide to Contractor aged listings of each Shop Drawing remaining in the office of Structural Engineer.

D. Product Data: Submit printed manufacturer's literature for each manufactured item specified under Part 2 - Products, along with test data as may be requested. Include detailed instructions for application and installation.

E. Names of Manufacturers/Suppliers: Submit for acceptance the names of the following products along with certification that the products conform in all respects to the requirements of the Contract Documents:

1. cement
2. aggregates
3. admixtures
4. fly ash, blast furnace slag, and other natural pozzolans
5. ready-mix concrete
6. form sealers and release agents
7. reinforcing bars, including epoxy-coated reinforcing bars
8. steel welded wire fabric, including epoxy coated welded wire fabric
9. reinforcing bar mechanical connections
10. deformed bar anchors
11. non-shrink grout and epoxy grout
12. bonding compound and epoxy adhesive
13. polymer patching/feathering compound
14. post-installed anchors
15. self-drilling fasteners
16. polyurethane sealant
17. joint filler and compressible filler
18. cellular glass and cellular polystyrene
19. bond breaker
20. moisture-retaining covers
21. curing and sealing, strippable curing compound, and liquid/sealer densifier
22. non-oxidizing metallic hardener
23. evaporation retarder
24. surface retarder
25. concrete cleaning/finishing solution
26. other products, material and fixtures, as specified herein

F. Mill Tests: Submit certified mill test reports for cement, for steel reinforcement, including bars, welded wire fabric and dowels,. Provide also to governing agencies having jurisdiction.

1. Mill test reports shall state clearly the governing ASTM specification and shall be certified and notarized by Contractor as conforming in all respects to that specification.

G. Epoxy Coating Plant Certification: Submit copy of current CRSI Epoxy Coating Plant Certification.

H. Reinforcing Bar Mechanical Connections: Obtain from manufacturer and submit a certified affidavit indicating compatibility of reinforcement, including bar deformations, with mechanical connection assemblies.

I. Certification for Curing Compounds and Sealers, Hardeners, Dustproofing, etc.: Submit certificate of compatibility with concrete and with materials to be applied to concrete surface.

J. Certification for Admixtures: Submit notarized document of compatibility of each admixture with all other concrete ingredients and with each applicable concrete surface treatment.

K. Design Mixes as provided in Part 2 of this Specification. Submit proposed mix designs for both concrete and grout on the Mix Design Submittal Form included with this specification. Submit test results and other supporting data on each mix design.

L. Post-Installed Anchor Certificates: Submit approved independent testing report per ACI 355 (ICC-ES report), Manufacturer's Printed Installation Instructions, letter describing installation procedures, and installer qualifications including certification for horizontal and overhead adhesive installation where applicable.

M. Protective Measures: Contractor's construction procedures shall be typewritten and shall include charts and diagrams, as applicable and necessary, to explain fully the proposed procedures, methods, equipment and operations in order to allow review, assist the Testing Agency's evaluation of the Work, and to allow Contractor's personnel to perform Work in full conformance to the Contract Documents. Submit procedures for the following:

1. Both hot, normal and cold weather concreting procedures shall be submitted not less than four weeks before beginning the Work of this Section, regardless of the need for the immediate implementation of such procedures. Procedures shall include hot weather cooling systems, cold weather heating systems, insulation, enclosures, provisions for mass concrete work and the like. Finishing procedures and timing and duration of curing shall be described.
2. Protection of concrete against injury due to mechanical contact and construction operations.
3. Welding of reinforcing bars and dowels.
4. Protection of curtain wall and other systems.
5. Protection of waterproofing and the like.
6. Protection of Work by other trades.
7. Formwork removal and reshoring procedures. Procedures unique to hot and cold weather conditions shall be identified. Shoring and reshoring drawings and calculations shall be prepared under the supervision of and signed by Contractor's Professional Engineer.

N. As-Built Shop Drawings: In a format acceptable to each, and at the completion of the Work, provide to Owner, to Architect and to Structural Engineer, one complete digital set of all Shop Drawings (including field changes, Field Work Drawings, and the like), so as to provide as-built drawings of finished and completed Work under this Section.

O. Governing Agencies: Provide all drawings, tests, inspections, reports, affidavits, manufacturer's certifications, certification of compliance with VOC limits, and other requirements and data to governing agencies having jurisdiction.

1.6 MEASUREMENTS AND TOLERANCES

A. Measurements:

1. Field Measurements: Obtain all field measurements required for proper fabrication and installation of Work covered by this Section. Submit, prior to installation, all measurements indicating discrepancies from the Drawings. Describe in writing and, where applicable, by sketches proposed methods of correcting discrepancies. Measurements are the responsibility of Contractor.

2. Lay out each part of the Work in strict accordance with the Architectural, Structural, Mechanical, Electrical, Plumbing and all other Drawings and be responsible for correct location of same. Lay out from at least two pre-established benchmarks and axis lines, individually correct for length and bearing.

3. Field Survey: Provide all field survey measurements required by Construction Manager for coordination with Curtain Wall and other trades installation.

B. Allowable Tolerances: Conform to the requirements listed below and as given in ACI 117, whichever is more stringent; provide more restrictive tolerances where required to meet job conditions and *Building Cod*e. Tolerances indicated shall apply to the full height of the building. Variations from grade and flatness of Work may be measured prior to removal of supporting formwork or shores and shall be taken as either plus or minus from a true line.

1. Level Alignment:
   a) Elevation of top of slab, 3/4 inch (20 mm).
   b) Elevation of formed surfaces before removal of shores, 3/4 inch (20 mm).
   c) Lintels, sills, parapets, horizontal grooves and other lines exposed to view, 1/2 inch (13 mm).

2. Building Lines: Variations of the linear building lines from established position in plan and related positions of columns, walls, beams and partitions:
   1/4 inch (6 mm) in 10 feet (3 m);
   3/8 inch (9 mm) in 20 feet (6 m);
   1/2 inch (13 mm) in 40 feet (12 m); and
   1 inch (25 mm) maximum.

3. Sleeves and Openings: Variations of the sizes and locations of sleeves, floor and wall openings and the like shall not exceed minus 1/4 inch (-6 mm) or plus 1 inch (+25 mm) from size and 1/2 inch (13 mm) from centerline locations given in accepted Shop Drawings.

4. Anchors and Inserts: Variations in the location of anchors and inserts shall not deviate more than 3/8 inch (10 mm) vertically nor 1/4 inch (6 mm) horizontally from positions shown in accepted Shop Drawings.

5. Cross-Sectional Dimensions of columns and beams and the thicknesses of slabs and walls shall not deviate from theoretical by more than the following:

a) for dimensions of
12 inches (300 mm) or less ..... +3/8 in.(+10 mm), -0 in.(-0 mm)

b) for dimensions of more than
12 inches (300 mm) but not over 36 inches (900 mm) +1/2 in.(+13 mm), -3/8 in.(-10 mm)

c) for dimensions over
36 inches (900 mm)..... +1 in.(+25 mm), -3/4 in.(-19 mm)

6. Footings shall vary in plan dimension from theoretical by not more than -0.5 inch (-13 mm) nor more than +2 inches (+50 mm). The center of gravity shall be within 2 percent of the theoretical footing dimension but, in no case, shall deviate from theoretical by more than 2 inches (50 mm). Footings shall not be reduced in thickness by more than 5 percent of the specified thickness but, in no case, shall the thickness be less than the theoretical by more than 3 inches (75 mm).

7. Grade beam forms shall be braced during the forming, concrete placement and curing stages so as to produce straightness and vertical alignment which does not deviate from theoretical position by more than specified tolerances.

C. Flatness/Levelness Tolerances for Floors: The flatness/levelness of floors shall conform to the requirements of Table 1.6-1 and will be determined in accordance with ASTM E 1155 (ASTM E 1155 M), *Standard Test Method for Determining Floor Flatness F_F and Floor Levelness F_L Numbers*.

TABLE 1.6-1 MINIMUM ACCEPTABLE VALUES FOR FF AND FL			
Location	Steel Trowel Finish	Float Finish Exposed Broom Finish & Garage Floors	Scratch Finish
1. Slabs-on-Ground:			
a) Specified Overall Value:	FF = 35/ FL = 25	FF = 20/ FL = 15	FF = 15/ FL = 13
b) Minimum Local Value:	FF = 25/ FL = 20	FF = 15/ FL = 13	FF = 13/ FL = 10

Where:

i) The Specified Overall Value is the minimum acceptable FF or FL value determined where all measured values of that type on a given Test Surface are combined per ASTM E 1155.

ii) The Minimum Local Value is the minimum acceptable FF or FL value determined for a given Test Section as defined below.

iii) A Test Section shall be bounded by column lines and half column lines, or by construction, control and/or expansion joints, whichever is smaller, but in no case shall a Test Section area be smaller than 320 square feet (30 square meters) or larger than 540 square feet (50 square meters). Test Sections shall also satisfy the criteria set forth in ASTM E 1155.

1.7 TESTING AND INSPECTION

A. Owner's Testing Agency: All Work is subject to Special Inspection as required by *Building Cod*e. Subject to acceptance by Architect, Owner will engage and pay for the services of an independent testing agency (Testing Agency) as outlined in Section 01 40 00, Inspection and Testing. The selected Testing Agency will meet the requirements of ASTM E 329. Contractor alone is responsible for the achieving of the required level of quality, both in the shop and in the field. Testing Agency will rely heavily on reviewed Shop Drawings, as described earlier in this Specification, in its examination of as-constructed Work. Contractor shall not retain Owner's Testing Agency for its own Work but may, subject to acceptance, contract through Owner for such work.

B. Responsibilities and Duties of Testing Agency: Testing Agency will perform the following functions, inspections and tests:

1. On instructions and at locations selected by Architect, Testing Agency may sample materials taken from the as-erected Work.

2. Take steps to ascertain that concrete is proportioned and mixed in accordance with the requirements of the Drawings and this Specification.

3. Maintain a presence at the project site during the placing of concrete.

4. Examine formwork for general conformance with the requirements of this Specification.

5. Examine as-placed reinforcing steel for general conformance with the requirements of the Drawings and of this Specification.

6. Receive and review concrete batch/truck tickets at time of delivery and prior to discharging concrete. Review of batch tickets shall include the comparison of actual material and quantities batched to mix design target values.

7. Monitor the methods of conveying concrete from the mixer to the point of placement in the Work.

8. Make, perform and evaluate testing of concrete cylinders in accord with this Specification, with ASTM C 31 and ASTM C 39, and as provided in Section 01 40 00. Capping for concrete cylinders shall be in accordance with either ASTM C 617 (bonded caps) or ASTM C 1231 (unbonded caps).

a) For each class and strength of concrete take the minimum cylinders indicated below, for each day's work, but not less than for each 100 cubic yards (75 cubic meters) of concrete nor less than for each 4300 square feet (400 square meters) of surface area for slabs or walls. Cylinders shall be tested in the schedule listed below. Where 28 days cylinders fail to conform to the requirements of this Specification, cylinders will be held and tested at 56 days (at 90 days for high strength or mass concrete);

Cylinder Size	Total Cylinders	Cylinder Testing Schedule			
		@7 days	@28 days	@56 days	@90 days
4" x 8"	7	1	3	3	0
6" x 12"	5	1	2	2	0
4" x 8" *	10	1	3	3	3
6" x 12" *	7	1	2	2	2

* For High Strength Concrete [f'c > 8500 ksi (60 MPa)]

b) Where, after sampling any third portion of a truck load, the elapsed time exceeds 30 minutes, a set of 5 test cylinders will be taken from each third of the load taken at intervals greater than 30 minutes;

c) Monitor protection systems for test cylinders; and

d) Identify all test cylinders as to placement date and location, concrete mix type and designation number, concrete batch ticket serial number, and other pertinent data.

9. Perform slump tests in accord with ASTM C 143.

a) Take one test at the beginning of each placement, both at the truck and at the point of discharge, one test at the taking of test cylinders and such other tests as are deemed appropriate by Testing Agency, by Construction Manager, or by Architect.

10. Perform air entrainment tests in accord with ASTM C 231 (ASTM C 173 for concrete with lightweight or high absorption aggregates).
   a) Take one test at the beginning of each placement, one test at the taking of test cylinders and such other tests as are deemed appropriate by Testing Agency, by Construction Manager, or by Architect.

11. Determine the temperature of freshly mixed concrete on a random basis during concrete placement in accord with ASTM C 1064.

12. Testing Agency may visit the batch plant as often as weekly, more or less often where directed. Each visit will involve one or more of the following operations:
   a) Examine aggregates for grading, cleanliness, moisture content, and the like;
   b) Examine plant operation and equipment such as stock piles, bunker loading, scales, mixer, cement, water and admixture dispensing;
   c) Review proportioning of mix, particularly for free moisture and the like; and
   d) Truck loading.

13. Perform physical testing of mechanical connections for reinforcement. In accordance with ASTM A 370, record the failure mode (bar fracture, coupler fracture, bar pull-out, etc...), maximum stress at yield, maximum load, ultimate tensile strength, elongation at failure, modulus of elasticity, diameter and area of reinforcement, and other pertinent data.

14. Test floor slab finished surface for flatness and levelness in accord with ASTM E 1155 and with this Specification.
   a) The Floor Flatness/Levelness Inspector shall be certified by the Face Companies of Norfolk, Virginia as being competent in F-Number measurement using the Dipstick Floor Profiler. This person shall have tested not less than 250,000 square feet (23,000 square meters) of floor surface using ASTM E 1155 and the F-number system.
   b) Measure slab elevations with a device capable of measuring and recording slab elevation changes of 0.002 inches (50 µm). Use Dipstick by Face Companies, F-meter by Allen Face & Company, or other accepted device.
   c) Where the area of slab surface which falls within 24 inches (600 mm) of construction joints exceeds 25 percent of the slab surface, the entire surface shall be tested, including those areas within 24 inches (600 mm) of construction joints.
   d) Complete testing within 24 hours of placement and before shores are removed, and submit results, including a key plan showing area tested, data sheets and all results required by ASTM E 1155, within 48 hours of placement. Identify clearly all defective areas. Submit to Owner, Architect and Contractor.

15. Maintain a copy of ACI 311.1R - ACI Manual of Concrete Inspection, ACI 311.4R - Guide for Concrete Inspection and ACI 311.5R - Batch Plant Inspection and Field Testing of Ready-Mixed Concrete.

16. All test reports indicating non-compliance shall be emailed immediately to all participants listed on the distribution list and the hard copy shall be sent on different colored paper.

17. Perform Special Inspection of post-installed anchors in accordance with the Building Code, Manufacturer's Printed Installation Instructions, approved independent testing report per ACI 355, Contract Documents and approved shop drawings. As a minimum, provide continuous inspection of adhesive anchors installed in horizontal, or upwardly inclined orientations, supporting tension loads; and periodic inspection of all other conditions of post-installed anchors. Special Inspectors shall be qualified (via experience, training, ACI/CRSI certification, etc.) with the installation and inspection of post-installed anchors. Special Inspections shall include but are not limited to the following:

a) Verify installer qualifications as required per the Contract Documents;
b) Verify anchor type, material, size, length, and condition;
c) Verify minimum concrete age, temperature, strength, and dry condition;
d) Verify drilling method, hole cleaning, preparation per Manufacturer's Printed Installation Instructions; and
e) Verify anchor position, setting, and installation method

C. Authorizations: Owner's Testing Agency will not be authorized to:

1. Authorize or accept deviations or substitutions from the Contract Documents.
2. Assume any of the responsibilities of Contractor; for example, Testing Agency may not advise formally or informally on any aspect of construction means, methods, techniques, sequences or procedures, or safety precautions and programs in connection with the Work.
3. Accept Shop Drawings or samples.
4. Approve or issue a Certificate of Payment, a Change Order, or issue verbal or written instructions which modify the Contract between Owner and Contractor.

D. Responsibilities and Duties of Contractor:

1. Performance or waiving of inspection, testing or surveillance by Testing Agency for a given portion of the Work will not relieve Contractor from responsibility to conform strictly to the requirements of the Contract Documents.
2. Notice: To facilitate and to assist testing and inspection, Contractor shall cooperate by providing proper notice of the initiation of Work. Provide 24 hours minimum notice of each concrete placement or other operation requiring plant or job site testing or inspection.
3. Access to Documents, Facilities and Materials: Furnish one copy of each accepted Shop Drawing and of each mill test certificate to Testing Agency. Provide reasonable office, desk and file space at each location of the Work and at the site to allow Testing Agency to work conveniently with and to maintain project records and drawings. Provide authorized personnel convenient and free access to all parts, locations and areas of Work, including storage areas. Provide hoisting, turning and moving of materials and reasonable quantities of scaffolding, power, casual labor, and other provisions and assistance necessary to allow quality and effective inspection and testing of Work.

4. Provide suitable and adequately sized storage and initial curing facilities for concrete test cylinders. Conform fully to the requirements of ASTM C 31. Provide all necessary job site facilities required to allow and assist Testing Agency to perform its tests and inspections in full conformance to all applicable standards, codes, and provisions of this Specification.

5. Secure and deliver to Contractor's independent testing laboratory without additional cost to Owner, representative samples of each material or ingredient required to be tested and certified prior to submittal for acceptance.

6. Reimburse Owner for the actual cost of all tests performed exclusively for the Contractor's convenience (such as job cured cylinders for early stripping of formwork) and for all tests and retests made necessary by initial nonconformance to Contract Documents.

7. Cost of Owner's Tests by Testing Agency will be borne by Owner. However, where additional tests are deemed necessary by Construction Manager or by Architect on account of failure to pass tests, the cost of additional testing will be deducted from payments to Contractor so as to reduce the Contract price.

1.8 QUALITY ASSURANCE

A. Source Quality Control: Contractor's material control procedures shall be effective and shall assure that all Work fulfills the requirements of the project as well as the applicable provisions of the Contract Documents. All materials shall be tested in accord with the requirements of *Building Code*, of Building Department, of governing authorities having jurisdiction and of this Specification.

B. Shop and Construction Site Quality Control: Contractor shall maintain, on staff, sufficient office, field engineering, and field supervision staff to assure that all data and layout drawings for Work of other Sections is transmitted to detailers to allow proper detailing of holes, penetrations, chases, and the like and to assure proper execution of the Work in the field.

C. Minimum Qualifications: Fabricator, installer and detailer of reinforcing steel shall each have experience with at least five buildings of the type of this work.

1. The reinforcing steel detailing firms shall be subject to acceptance. Detailing firms shall demonstrate in-house quality control procedures to the satisfaction of Construction Manager and of Architect. Acceptance of reinforcing steel detailer is provisional and may be withdrawn where detailing is not of sufficient quality to meet project requirements.

D. Concrete Strength: Evaluation and acceptance of concrete strength shall conform to the requirements of ACI 318. Where laboratory cured cylinder test results do not satisfy these requirements, Contractor shall make sufficient and appropriate changes to concrete proportions for the remaining Work in order to assure acceptable strength test results. Where required, Contractor shall provide also reshoring and additional curing of concrete slow in attaining design strength. Additionally, at its sole discretion, Construction Manager or Architect may permit or require core tests in accord with ASTM C 42. Load tests shall not be performed without Construction Manager's or Architect's specific concurrence, and then only after acceptance of comprehensive, detailed procedures prepared by, signed and sealed by Contractor's Professional Engineer, and submitted in writing.

1. Core tests may be required of Contractor where:
   a) the average of one or more sets of three consecutive strength tests falls below f'c;
   b) one or more individual strength tests falls below f'c by more than 500 psi (3500 kPa);
   c) strength tests of field-cured cylinders, accomplished at the designated age, fall more than 15 percent below strength tests of companion laboratory-cured cylinders;
   d) samples of concrete for acceptance test cylinders are not representative of concrete in place in the structure.

2. Perform all tests, and all corrective and restorative measures at no expense to Owner. Construction Manager and Architect shall be sole interpreter of the need for additional tests, and Construction Manager's and Architect's judgment shall be binding on Owner and Contractor alike.

3. Laboratory cured cylinders shall not be used for evaluating either compressive strength or acceptable condition of concrete suspected of being frozen, or for determining strength of concrete for early stripping of formwork.

4. Should core specimens be taken, Contractor shall plug all core holes solid with matching concrete or non-shrink grout as directed. All such plugging shall be Contractor's responsibility and shall be performed at no expense to Owner. All such work shall be subject to acceptance and to correction by Contractor, where not in conformance with the Contract Documents.

E. Qualifications: Contractor shall determine, shall warrant and shall certify that producers, epoxy coating applicator, reinforcing steel detailer, fabricator and installer, formwork constructor, concrete placer, finisher and all others involved in the Work, along with their personnel, are experienced, qualified and adequately staffed to undertake the specific Work required under this Section.

F. Reinforcing Bar Mechanical Connections shall be installed and torqued by workers having demonstrated experience and/or current training in manufacturer's procedures and techniques.

G. Post-Installed Anchors shall be installed by workers with experience and training with installing the specified anchors. Installation of adhesive anchors in horizontal or upwardly inclined orientations supporting tension load shall be performed by installers certified through the ACI/CRSI adhesive anchor installer certification program, or approved equivalent.

H. Documentation of Contract Conformance: Perform quality control functions required to achieve and to document that Work conforms to the Contract Documents. Provide access to Contractor's quality control documents and reports upon request. Provide reasonable numbers of copies of specific quality control reports on request.

I. Purchase Orders: Each purchase order shall identify the end use of the purchased material. Contractor shall ensure that manufacturer or vendor understands fully the intended use of the material in the Work.

1.9 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Original Containers: Materials shall be delivered to the site, ready for use, in the manufacturer's original and unopened containers and packaging, bearing original labels as to type of material, brand name, and manufacturer's name. Delivered materials shall be identical to accepted samples.

B. Storage: Materials shall be stored under cover in dry, weathertight, adequately ventilated and clean locations off the ground. Storage methods shall also provide for free and rapid drainage of rainwater and shall prevent collection of water on or within stored materials. Post-installed anchors shall be stored in accordance with manufacturer’s requirements.

C. Protect reinforcing steel and mesh from scaling, oil, grease and distortion. Reinforcing steel and mesh that has rusted to the extent of scaling will be rejected and may be placed in the Work only after proper cleaning, and shall be subject to acceptance.

D. Aggregates to be used in field mixed concrete or grout shall be stockpiled in separate bins or piles in a manner suitable to minimize segregation and contamination of aggregates. Field mixing is not encouraged and will be allowed only with specific written permission.

E. Removal: Delivered materials which are damaged or otherwise not suitable for installation, shall be removed from the job site and replaced with acceptable materials.

1. Construction Manager and Architect shall be the sole judge of the suitability of such materials and neither Owner nor Contractor may challenge Construction Manager's or Architect's decisions as to acceptability.

F. Batch/Truck Tickets: Provide a copy of each batch ticket for each batch of concrete discharged and used in work. Batch tickets shall be submitted to Owner or Owner's inspection agency prior to discharging concrete. Contractor shall retain duplicate tickets until such time as Owner has received a Certificate of Occupancy. Tickets need indicate the following:

1. Ready-mix batch plant name and location.
2. Project identification number, name and location.
3. Serial number of ticket.
4. Truck number.
5. Mix type and designation number.
6. Date and time of first mixing of cement and aggregates.
7. Actual material and quantities batched, both at plant and site, including total free water and admixtures. Total free water includes free water on the aggregates, water in each admixture, water and ice.
8. Amount of concrete batched.
9. Signature of plant quality control supervisor and, if water and/or admixtures are added at the site, site quality control supervisor.

1.10 JOB CONDITIONS

A. Contractor's Responsibility: Contractor shall be solely responsible for the correctness of dimensions and quantities and for the fitting to other Work; for Work to be confirmed and correlated at the site; for information pertaining to the fabrication procedure or to the means, methods, techniques, sequences and procedures of construction; and for the coordination of the Work of this Section with the Work of all other trades. The verification of the physical interrelationships of elements of the Work from Contract Documents and in the field is solely Contractor's responsibility. Review of Contractor's submissions does not relieve Contractor from these responsibilities.

B. Contractor's Coordination: Contractor shall coordinate and schedule the Work of this Section with the Work of other Sections of this Specification in order to optimize quality and to avoid delay in overall job progress.

C. Rejection of Work: Testing Agency may inspect and test materials at the source before shipment as well as at the site before, during or after installation in the Work. Construction Manager and Architect reserve the right, at any time before final acceptance of the completed Work, to reject material not conforming with specified requirements, regardless of previous tests, inspections, acceptances, or inclusion in certificates of payment.

D. Provisions for Other Work: The Work under this Section shall include required cutting, forming, reinforcing steel and all else required for the passing through and attachment of other Work.

E. Equipment Bases and Foundations: Unless given in the Contract Documents to the contrary, equipment bases and foundations shall be reinforced with not less than #5 at 12" (300 mm) o.c., top and bottom, each way.

F. Construction Sequence: Descriptions of limitations on construction sequence are intended to assist Contractor in coordinating the Work of the Project. Descriptions do not describe fully the limitations given, do not describe all limitations, nor do they preclude construction sequences not contemplated herein.

1. Generally, the structure is to be constructed from the bottom to the top, floor-by-floor, with Contractor supplying such temporary bracing and shoring as may be required to compensate for the lack of completion of portions of the construction.
2. Do not backfill behind earth-retaining walls until needed permanent construction or adequate shoring is in place.
3. Plan and accomplish construction sequence in accord with Structural, Architectural, Mechanical, Electrical and all other Drawings, forming a part of the Work.

G. Construction Loads: The structure is designed to resist safely the loading prescribed by *Building Code* for the finished building. No provisions is included for loads or stresses imposed or induced by Contractor's means and methods of construction. Design loads are provided in *Building Code* but are sometimes modified upward as provided in Structural Engineer's Design Criteria.

1. Where Contractor elects to place loads on the structure or elects to otherwise load or deform the structure in excess of the design loads, Contractor shall submit drawings and supporting calculations prepared under the supervision of and sealed by Contractor's Professional Engineer licensed in the project's jurisdiction.
a) Review of Contractor's submittal shall not relieve Contractor from full responsibility for Contractor's means and methods of construction.
2. Alternatively, Contractor may seek professional services from Structural Engineer. Such services may be obtained through Owner or, with the permission of Owner, may be obtained directly from Structural Engineer. Architect will not be involved contractually in any such services.

H. Accidents and Hazardous Conditions: Contractor shall prepare and shall submit promptly a detailed written report of all accidents and other occurrences involving death, significant personal injury and/or significant losses in tangible property.

I. Installing and Rigging Equipment: Contractor shall shore all construction susceptible to impact loading from the installation of equipment installed by other trades.

1. Such equipment shall include but shall not be limited to boilers, chillers, refrigeration equipment, pumps, transformers, elevator machines and the like.
2. Remove shoring when equipment installation is complete but not before structure has achieved design strength.

1.11 DEFICIENT WORK

A. Repairing, Patching, Cleaning: Contractor shall correct all Deficiencies in the Work of this Specification including areas where Testing Agency reports, or Construction Manager's or Architect's rejections have indicated that Work is not in full compliance with the Contract Documents. Perform, at no expense to Owner, all additional tests that Construction Manager or Architect deems necessary to reconfirm noncompliance of the original Work and perform, at no expense to Owner, all tests and inspections which may be necessary to show compliance of corrected Work.

B. Defective and Nonconforming Work: Defective Work, unsuitable Work, or Work otherwise failing to conform to the Contract Documents shall be made good by Contractor at no change in the amount of or the time of the Contract. Contractor shall prepare appropriate details and procedures for bringing such Work into conformance with the Contract Documents and shall submit such details and procedures for acceptance. Corrective Work, including materials, shall conform strictly to accepted details and procedures. Nonconforming Work may be rejected at any time, regardless of prior acceptance in Shop Drawings, prior inspection, inclusion in inspection or test reports, or inclusion in certificates of payment.

C. Deficiencies: Where Work exhibits any one or more of the following deficiencies, or where Work otherwise fails to conform to the requirements of the Contract Documents or to the requirements of *Building Code*, for any reason or combination of reasons, such Work shall be considered Deficient and not in conformance with the requirements of the Contract:

1. Low cylinder strength at 28 days, as defined by this Specification.
2. Excessive or deficient water, air, cement, admixture, or any other material.
3. Slump and slump-flow not in accord with this Specification.
4. Unauthorized addition of water.
5. Spalling, honeycombing or the like.
6. Unauthorized cutting, chopping, construction joints, cold joints and so forth.
7. Workmanship not in accord with the Drawings, with this Specification, with accepted samples, or with referenced codes or standards.
8. Cracking, surface defects, or improper consolidation.
9. Exceedance of tolerances, lack of alignment, and incorrect forming.
10. Floor flatness/levelness F-numbers (either FF, FL or both) which measure less than specified minimum values.
11. Evidence of freezing, improper curing and the like.
12. Contact with aluminum or with aluminum alloys except where specifically permitted under this Specification.
13. Post-installed anchors not set in accordance with Manufacturer’s Printed Installation Instructions, adhesive anchors not set with insufficient adhesive (no overfill visible).
14. Use of non-conforming materials or systems.

D. Replacement or Repair: Where Construction Manager or Architect, at its sole discretion, finds any of the above deficiencies or other Work not in accord with the requirements of the Contract Documents, Construction Manager or Architect may order that the affected Work be replaced or repaired at Contractor's expense.

1. Contractor shall reimburse Owner for the actual amount of the fees of Testing Agency for the reinspection and the retesting of Work deemed defective by Construction Manager or by Architect.

E. Cost: The cost of all other activities and procedures associated with defective Work shall be paid by Contractor.

PART 2 - PRODUCTS

2.1 CONCRETE MIXTURES

A. Contractor Furnished Mix Designs: For each type and strength of concrete mixture and grout mixture required in the Work, Contractor shall submit for Architect's acceptance a mix design. Each mix design shall conform to the applicable provisions of this Specification and *Building Cod*e. Mix designs shall be established by Contractor's Professional Engineer licensed in the project's jurisdiction on the basis of field experience and or trial mixes prepared by Contractor and both monitored and tested by an independent testing laboratory retained and paid by Contractor. Mix designs in current use, documented by current test reports, may be submitted for acceptance in accord with ACI 301. All mix designs shall be submitted on the Mix Design Submittal Form included in this specification. This form is available electronically for Contractor's use.

1. Contractor shall be fully responsible for conformance to all mix design and control provisions of this Specification and for the strength, consistency, and handling of concrete. Concrete supplier, and admixture manufacturer(s) shall state and certify that the proposed concrete mixes and placing procedures will produce the strengths, finishes, densities and like qualities required by this Specification.

2. Mix designs may be adjusted by Contractor to suit minor variability of materials, job conditions, weather, test results and other data, subject to acceptance and provided there is no change in the amount of the Contract; laboratory data for revised mix designs shall be submitted and accepted prior to use in the Work.

3. Contractor shall pay all costs associated with preparing, testing, documenting and submitting design mixes for each concrete mix design used in the Work.

4. Contractor shall provide notification of the time and location where each trial mix will be prepared and/or tested.

B. Concrete Mix Requirements: Proportions for each mix shall provide for homogeneous, cohesive, workable and dense concrete, suitable in all respects for its intended purpose. Concrete mixes shall be selected to provide for requirements not less than those required by Table 2.1-1. All concrete shall have a maximum shrinkage of 0.04% at 28 days when tested in accordance with ASTM C157, 7-day moist cure.

TABLE 2.1-1

Nominal Strength f'c @ 28 days psi (MPa) Note 1	Type of Concrete	Minimum Cementitious Content Lbs. Per CY (Kg per CM) Note 2	Maximum Water-Cementitious Material Ratio Note 3
Structural Concrete			
5000 (34)	normal weight	635 (377)	0.42
5000 (34)	pea gravel	700 (415)	0.42
4000 (28)	normal weight	540 (320)	0.50
4000 (28)	pea gravel	600 (386)	0.50
Slab Concrete			
4000 (28)	NW slab on ground and topping slab		
	(interior)	575 (340)	0.50
	(exterior)	610 (360)	0.45

Note 1: f'c in accord with ACI 318 Articles 5.3.2 and 5.3.3.

Note 2: Minimum cementitious means total weight of cementitious material as permitted by this Specification (cement, slag, fly ash, and silica fume).

Note 3: Maximum water-cementitious material ratio will be reviewed for conformance to ACI 318 paragraph 5.3.3.2 (f). Field documented mix designs shall be responsive to this requirement.

Note 4: All concrete exposed to chlorides or sulfates in water, soil, or spray zones, or exposed to deicer chemicals shall have a maximum water-cementitious ratio of 0.40 (minimum f'_C of 5000 psi or 34 MPa at 28 days).

All concrete exposed to water shall have a maximum water-cementitious ratio of 0.45 (minimum f'_C of 4500 psi or 31 Mpa at 34 days) to provide low-permeability.

All trowel finished interior slabs, subjected to small hard-wheeled vehicular traffic, shall have a maximum water/cementitious ratio o 0.53.

1. Each mix shall be proportioned to fulfill the water-cementitious material ratio at the maximum permitted slump. Self-consolidating concrete mixes shall be proportioned to fulfill the required workability criteria range and the water-cementitious material ratio and shall be established on the basis of full scale testing at the plant or site as well as trial mixes and mock-ups. In designing the mix, the size and the form of the structure, the dimension and density of reinforcement and cover should be taken in consideration.
2. Contractor may use fly ash or other pozzolans to replace not more than 30% by weight, pound for pound, of required cement. Contractor may use slag to replace not more than 40% by weight, pound for pound, of required cement. Fly ash or slag may not be used to substitute for cement conforming to ASTM C 595, (i.e., for pozzolan modified cement). Silica fume may be used to replace not more than 10% by weight, pound for pound of required cement. The total amount of fly ash and other pozzolans, slag, and silica fume shall not exceed the limits of ACI 318 Table 4.4.2 for concrete exposed to deicing chemicals.
3. Use admixtures as required by this Specification and as recommended by admixture manufacturer for the specific climatic conditions at the time of placement.
4. Slump of less than 3 inch (75 mm) at point of discharge will not be permitted except where allowed specifically in this Specification.
5. Slab on ground and topping slab concrete shall be macro synthetic fiber reinforced concrete. Minimum dosage shall be 4 lbs/cy unless otherwise noted.

C. Air-Entrainment: Concrete shall be air-entrained in accord with Table 2.1-2 except that entrained air is not required for concrete for footings, interior slabs on ground to receive steel troweled finish, piling or pile caps where such concrete will not be subject to freeze/thaw. Lightweight concrete shall be air-entrained in accordance with Table 2.1-2 except that the entrained air shall be no less than 4% and no greater than 7% to meet U.L. fire resistance rating requirements.

TABLE 2.1-2

TOTAL AIR CONTENT*

Maximum Aggregate Size No.**	Maximum Nominal Size	Required Air Content (Percent)
# 467	1-1/2 (38 mm)	4.5 ± 1.5
# 57	1 (25 mm)	5.0 ± 1.5
# 67	3/4 (19 mm)	6.0 ± 1.5
# 7	1/2 (13 mm)	7.0 ± 1.5
# 8	3/8 (10 mm)	8.0 ± 2.0

* Interior slabs on ground, to receive steel troweled finish, shall have an air content not to exceed 2.0% ± 1%. No air entraining admixture permitted.

** Size designations per ASTM C 33 or C 330.

D. Slump and Slump-Flow: Concrete that is not self-consolidating shall be proportioned and produced to provide slump, at the point of delivery into the work, as tabulated in Table 2.1-3. A tolerance of not more than 1 inch (25 mm) additional will be allowed for one batch within each five consecutive batches of each mix design.

TABLE 2.1-3

Type of Concrete	Maximum Slump inches *
Normal Weight	4 (100 mm)
Pea Gravel	4 (100 mm)
Slab on Ground	4 (100 mm)
Topping Slab	3 (75 mm)
Pumped	Note 1
Ramps and Sloping Surfaces	3 (75 mm)

* Increased slump may only be achieved by the used of the specified HRWR admixture.

Note 1: All pumped concrete shall contain the specified HRWR admixture. Slump loss shall not be more than 2" from the pump to the point of deposit.

E. Water-Reducing Admixture shall be incorporated into all concrete (not required for mixes designed for superplasticized and self- consolidating concrete) at a minimum dosage of 3.5 fluid ounces per CWT (230 cm^3/100 kg) of cement, in strict conformance with manufacturer's directions. Contractor shall consult with admixture manufacturer and shall propose increased dosage rates as appropriate to achieve optimum workability, cohesiveness and uniformity of concrete mixtures as placed in the Work.

1. Use non-corrosive, accelerating admixture in concrete slabs and in other thin concrete work where concrete is placed at ambient temperatures below 50°F (10°C).

F. Superplasticized (HRWR) Concrete: Use in all pumped concrete and concrete with a water/cementitious ratio below 0.50 and in all locations where required to meet the requirements of the contract documents. Prepare with a high-range, water-reducing admixture (HRWR). Contractor's mix design shall also include written descriptions of Contractor's methods for mixing, placing and conveying concrete and shall also include design procedures to be used for the formwork.

1. HRWR mixes may be prepared to provide concrete with 9-inch (225 mm) maximum slump and intended slump of 8.0 +1 inch (200±25 mm) in lieu of the slump maximums specified herein, while adhering to the water-cementitious material ratio maximums specified. Alternatively, HRWR admixture may be used to provide concrete mixtures conforming to the specified maximum slump and water- cementitious material ratio values.

2. HRWR admixtures shall be incorporated into the concrete mixtures at the batch plant or in the field through an approved dispensing unit. Water content of this concrete will be verified on the job site by use of the specified microwave test.

G. Water-Cementitious Material Ratio: Calculate water-cementitious material ratio by dividing the weight of total free water (including water found in each admixture) in the concrete, per unit volume, by the number of pounds of cementitious material per unit volume. Total free water shall be taken as the total free water content of the mix when proportioned to produce the maximum allowable slump. Cementitious material is defined as cement, silica fume, fly ash and other natural pozzolans, and blast furnace slag. Water-cementitious material ratio shall be the decimal rounded to two significant figures obtained by dividing the total free water weight per cubic yard (meter) by the total weight of cementitious material per cubic yard (meter).

H. Cement Grout shall be composed of 1 part Portland cement and 3 parts fine aggregate, by volume, with minimum water to produce a stiff, but workable mix.

I. Source Changes: Should the source of an ingredient change, for any of the concrete products specified herein, Contractor shall redesign the affected mix and shall resubmit, all prior to incorporating such material into the Work.

J. Test Report Requirements: Contractor's test reports and Testing Agency test reports shall be prepared in a format as given in this Specification.

1. Mixes shall be designated by a number (Mix No. 1, Mix No. 2,...etc).
2. Individual samplings of a particular mix shall be designated by a number, with the first sample given the number 100 (Sampling 100, Sampling 101,...etc).
3. Test cylinder numbers shall be provided using the sample number and a letter (102A, 102B,...etc).
4. Contractor's Professional Engineer licensed in the project's jurisdiction shall review and shall sign each concrete test cylinder report indicating that the test shows conformance with the requirements of the Contract Documents.
5. Deviations from project requirements shall be identified clearly by circling non-conforming data and by overprinting in 1/2 inch (13 mm) high red letters "NON-CONFORMING."

2.2 CONCRETE INGREDIENTS

A. Cement: Provide an accepted, single source, standard brand Portland cement, conforming to ANSI/ASTM C 150, Type I, II or III or ANSI/ASTM C 595, Type IP. Cement shall be from a single domestic source.

1. Use Type I or Type II cement except where another cement is herein specified and except where permitted.
2. High-early strength, Type III, or other special cement, may be used in the Work only where permitted. The specified non-chloride admixture may be used.
3. For Slabs-on-Ground Concrete, provide ANSI/ASTM C 150, Type I or II, from a single domestic source.

B. Aggregate: Fine and coarse aggregates shall be regarded as separate ingredients. All aggregates shall meet the requirements listed below except that, where accepted by *Building Code*, non-conforming aggregates will be considered in accordance with the provisions of the Contract Documents.

1. Coarse Aggregate: shall conform to ANSI/ASTM C 33, and shall consist exclusively of sound and durable gravel or crushed stone, having clean, uncoated, hard and strong particles, free from soft, thin, elongated or laminated particles, and from deleterious materials such as alkali, organic, soft or expansive matter. ASTM Grade Size #67 (19 to 4.8 mm), #57 (25 to 4.8 mm) or #467 (37 to 4.8 mm). Aggregates in excess of 3/4 inch (19 mm) shall not be used except in footings and pile caps, except where required specifically by this Specification or by the Drawings and except where accepted in writing. Water absorption of dry aggregate shall not exceed 1 percent.

2. Fine Aggregate: shall conform to ANSI/ASTM C 33, consisting exclusively of natural sand or crushed stone screenings, having clean, uncoated, hard and strong particles, free from clay, shale, lumps, salt and flaky particles, and from deleterious materials such as alkali, organic, soft or expansive matter. Fine aggregate shall be evenly graded from fine to coarse, with a fineness modulus not less than 2.30, nor more than 3.10.

3. Combined aggregate gradation for slabs and other designated concrete shall be 8% - 18 % for large top size aggregates (1 ½ in.) or 8% - 22% for smaller top size aggregates (1 in. or ¾ in.) retained on each sieve below the top size and above the No. 100.

4. Concrete Topping: Coarse aggregate shall conform to ANSI/ASTM C 33 or C 330 as appropriate, ASTM Grade Size #7 or #8 (12 mm to 4.8 mm or 9.5 mm to 2.4 mm) and shall conform also to all requirements for Coarse Aggregate given above. Fine aggregate shall conform to all requirements for Fine Aggregate as given above.

5. Cement Finish: Aggregates shall be graded from 1/8 (3 mm) to 3/8 inches (10 mm), with not less than 95 percent of aggregate weight passing the 3/8 inch (10 mm) sieve.

6. For concrete exposed to view, provide both coarse and fine aggregates from a single, uniform source.

7. Cleanliness of Aggregate: Aggregates shall have a minimum C.V. (cleanliness value) and a minimum S.E. (sand equivalent) of 75.0. Three samples shall be taken from the weight hopper and the average of the results of the three individual tests shall be the accepted value. Tests shall be taken throughout the course of the Work. Deviation from the accepted value will be the cause of rejections of the material.

C. Water: Mixing water for concrete shall be clean, fresh, free from injurious amounts of oil, acid, alkalis, salts, organic materials and other deleterious materials and shall conform to ASTM C1602. Antifreeze agents may not be used unless accepted in writing. In case of uncertainty, water shall be potable.

D. Admixtures listed below by name and by brand are accepted for use in the Work. Other admixtures will be considered for use but are subject to acceptance. Admixtures contributing to chloride, fluoride, sulfide or nitrate ions, or to other substances detrimental to the ingredients of the concrete or to reinforcing steel, will not be permitted in the Work.

1. Water-Reducing Admixture shall conform to ASTM C 494, Type A.
- a) Pozzolith 322-N or Polyheed 997, by BASF.
- b) WR-91, or Plastol Series, by Euclid Chemical Co.
- c) Plastocrete 161 or Sikament HP, by Sika Corp.
- d) WRDA with HYCOL or Daracem 55, by W.R. Grace Construction Products.
- e) Other accepted admixture.

2. Retarding Admixture shall conform to ASTM C 494, Type B.
- a) Delvo ESC, by BASF.
- b) Eucon Retarder 100, by Euclid Chemical Co.
- c) Other accepted admixture.

3. Non-corrosive, Non-Chloride Accelerator: The admixture shall conform to ASTM C 494, Type C or E, and not contain more chloride ions than are present in municipal drinking water. The admixture manufacturer must have long-term non-corrosive test data from an independent testing laboratory (of at least a year's duration) using an acceptable accelerated corrosion test method such as that using electrical potential measures. Type C Admixtures are:
- a) Pozzutec 20+, by BASF.
- b) Accelguard 80, 90 or NCA by Euclid Chemical Co.
- c) Sika Rapid-1, by Sika Corp.
- d) Polarset, by W.R. Grace Construction Products.
- e) Other accepted admixture.

4. Water-Reducing, Retarding Admixture shall conform to ASTM C 494, Type D.
- a) Pozzolith 100 XR or 300 R, by BASF.
- b) Eucon Retarder 75 or 100, by Euclid Chemical Co.
- c) Plastiment or Plastocrete 161MR, by Sika Corp.
- d) Daratard 17, by W.R. Grace Construction Products.
- e) Other accepted admixture.

5. Non-Corrosive, Water-Reducing, Accelerating Admixture shall conform to ASTM C 494, Type E.
- a) Polyheed FC100, by BASF.
- b) Accelguard 80, 90, or NCA, by Euclid Chemical Co.
- c) Plastocrete 161FL, by Sika Corp.
- d) Other accepted admixture.

6. High-Range Water-Reducing Admixture (Superplasticizer) shall conform to ASTM C 494, Type **F.**
- a) Rheobuild 1000, by BASF.
- b) Eucon 37/1037, or Plastol Series by Euclid Chemical Co.
- c) Sika ViscoCrete 2100, by Sika Corp.
- d) ADVA 140M, by W.R. Grace Construction Products.
- e) Other accepted admixture.

7. High-Range Water Reducing, Retarding Admixture (Superplasticizer) shall conform to ASTM C 494, Type G.
   a) Eucon Retarder 75, by Euclid Chemical Co.
   b) Daracem 100, by W.R. Grace Construction Products.
   c) Other accepted admixture.

8. Air-Entraining Admixture shall conform to ANSI/ASTM C 260.
   a) Micro-Air or MB AE 90, by BASF.
   b) AEA-92 or Air Mix, by Euclid Chemical Co.
   c) Sika AER or Sika AEA-15, by Sika Corp.
   d) Daravair 1000 or Darex II AEA, by W.R. Grace Construction Products.
   e) Other accepted admixture.

9. Prohibited Admixtures: Calcium chloride thiocyanates and admixtures containing more than 0.05% chloride ions are not permitted

E. Chloride Ion: It is understood that certain admixtures do contain a concentration of calcium chloride. Design mix shall contain a summary of total calcium chloride concentration, including the content of admixtures. Total concentration in excess of that listed in ACI 318 Table 4.4.1 will be rejected without further review. Concentrations less than those listed in ACI 318 Table 4.4.1 may be accepted where, in the sole opinion of Construction Manager or of Architect, such concentration will not be detrimental to the Work. The amount of calcium chloride shall be determined by the method described in ASTM C 1218.

F. Fly Ash shall conform to ASTM C 618, Class C or F except that loss on ignition shall not exceed 3 percent and maximum percentage retained on the #325 (45 µm) sieve shall not exceed 20 percent. Fly ash shall be from a single, accepted source.

G. Natural Pozzolans, such as calcined clay, calcined shale, and metakaolin, shall conform to ASTM C618, Class N.

H. Blast Furnace Slag shall conform to ASTM C 989, Grade 120.

I. Fibrous Reinforcement shall conform to ASTM C 1116 Type III.

1. Synthetic Macro-Fibers: Structural fibers shall be a coarse monofilament, self-fibrillating, polypropylene/ polyethylene blend in accordance with ASTM C1116, Paragraph 4.1.3, Type III. Structural fiber shall have a minimum tensile strength of 73 to 80 ksi and a minimum length of 1.5 inches. To be used for slabs-on-ground
   a) Tuf-Strand SF, by Euclid Chemical Co.
   b) Strux 90/40, by W.R. Grace Construction Products.
   c) Other accepted fiber reinforcement.

2.3 FORMWORK MATERIALS

A. Form Contact Faces:

1. For Surfaces Not Exposed To View:

a) Lumber shall be stress grade lumber described and used in accord with the National Design Specification for Wood Construction. Lumber shall be dressed on three sides and ends for a tight fit.

b) Plywood for formwork shall be in accordance with U.S. Product Standard PS-1, Structural 1 "B-B (Concrete Form) Plyform", Exterior Grade, mill oiled and edge-sealed, not less than 9/16 inch (14 mm) thick. Field cut edges shall be resealed with a solvent-based sealant. Each piece shall bear the legible inspection trademark.

c) Chamfer Strips for outside corners in forms may be of wood, metal or PVC at Contractor's option. Rubber chamfer strips may be used only where not exposed to view.

B. Form Sealers and Release Agents shall be guaranteed by manufacturer to be non-grain raising, non-staining and to not impair the natural bond of paint, waterproofing and other surface coatings.

1. Form Sealer for Lumber Surfaces and Plywood Edges: Polyurethane, clear coating.

2. Sealer for Board Forms: Penetrating sealer, non-grain raising, non-staining, which does not leave a surface coating on the board forms. Accepted Sealer: Clear Pre-Form, by Nox-Crete, Inc., or other accepted sealer.

3. Form Release Agents: Provide chemically reactive, non-staining, non-toxic, commercially blended form release agents that are compatible with material subsequently applied and free from deleterious effects on final concrete surfaces or applied coatings and finishes. Products containing castor oil shall not be used in the Work. Special care need be taken with self-consolidating concrete to ensure that the form release agent has been applied to clean, smooth forms in a uniform and appropriate thickness.

a) General Purpose Form Release Agents

i) Formshield Pure, by Euclid Chemical Co.

ii) Debond Form Coating, by L&M Construction Chemicals, Inc.

iii) Nox-Crete Form Coating 250, by Nox-Crete, Inc.

iv) Other where accepted.

C. Other: Formwork materials not given herein or identified in Drawings shall be subject to acceptance.

2.4 REINFORCEMENT MATERIALS

A. Reinforcing Bars, Column Ties, etc.: Except where more stringent requirements are given in the Drawings or required by *Building Code*, provide ASTM A 615, new billet steel, deformed. Rail, axle, or rerolled steel shall not be used.

1. Provide Grade 60 unless otherwise given in the Drawings or in this Specification.
2. Where welding to structural steel, provide ASTM A 706, Grade 60♣.
3. Steel wire shall conform to ASTM A 82, plain, cold-drawn steel.

B. Welded Steel Wire Fabric: ANSI/ASTM A 497 (deformed wire) for sizes D4.0 and larger and A 185 (plain wire) for sizes less than W4.0, produced by a domestic manufacturer, with a minimum tensile strength not less than 70,000 psi (480 MPa). Provide, deliver and store as flat sheets only; rolls will not be permitted.

C. Epoxy-Coated Reinforcement and their Supports shall be subject to all applicable portions of this Specification and, in addition, shall be subject to the following:

1. Epoxy-coated reinforcement shall conform to ASTM A 775 and to ASTM A 615 or A 706 as appropriate; welded wire fabric shall conform to ASTM A 884, Class A and to ASTM A 497 or A 185.
2. Acceptable manufacturer shall be in possession of current CRSI coating plant certification.
3. Bar and mesh supports shall be manufactured from a dialectric material or shall be wire bar supports coated with a dialectric material such as epoxy or vinyl, compatible both with the concrete and with the epoxy coating. Coating of wire bar supports shall cover the entire bar support. Metal may not extend closer than 5/8 inch (16 mm) to the concrete surface and color of coating shall match that of the finished concrete.
4. Tie wire shall be nylon coated.
5. Proprietary combination bar clips and spreaders used in walls shall be non-corrosive, compatible both with the coating and with the concrete.

D. Deformed Bar Anchors shall be ASTM A 496 deformed bars prepared for stud welding in accordance with AWS D1.1. Material shall conform to AWS D1.1, Chapter 7, Type C. Accepted manufacturer is the Nelson Stud Welding Division of TRW or other accepted manufacturer. Provide 1/2 inch (12 mm) diameter, 36 inch (915 mm) long bars, unless otherwise given in drawings.

E. Tie Wire: 18 gauge (1310 µm) or heavier, black annealed wire, conforming to ANSI/ASTM A 82. Tie wire in concrete at exposed surfaces shall be non-corrosive; stainless steel, monel, or plastic coated.

F. Bolsters, Chairs, Spacers, and other devices for spacing supporting and fastening reinforcing bars and welded wire fabric:

1. Accessories shall be all-plastic or shall be plastic coated metal. Metal may not extend closer than 1/8 inch (3 mm) to concrete surface. Plastic color shall match finished concrete color. Conform to CRSI requirements.

2. For concrete surfaces exposed to view, bar supports shall be CRSI, Class 1 (plastic protected) or CRSI, Class 2 (stainless steel protected). Acceptable manufacturers are Dayton Superior, or other accepted manufacturer.

3. For slabs-on-ground, use precast concrete blocks or supports with base plates or with horizontal runners at all locations where base materials will not properly support the legs of chairs.

G. Reinforcing Bar Mechanical Connections: Unless given in the Contract Documents, mechanical connections shall develop in tension and compression not less than 125 percent of the specified yield strength of the bar and shall have current ICBO approval.

1. Tension-compression mechanical connections shall utilize thread-deformed reinforcing bars.
   a) BPI Barsplicer, by BarSplice Products, Inc.
   b) D-101, by Dayton Superior.
   c) Lenton, by Erico International Corp.
   d) Other where accepted.

2. Mechanical lap slices shall be the shear screw double wedge coupling sleeve type, with converging sides and cone-pointed hex-head screws opposite the wedges and shall develop in tension and compression not less than 125 percent of the specified yield strength of the bar.
   a) Double Barrel Zap Screwlok, by BarSplice Products, Inc.
   b) Other where accepted.

3. Welded splices may be used at all locations where mechanical connections are permitted, but shall require ASTM A 706 reinforcing and shall be by complete penetration butt weld. Both reinforcement and welding shall conform to the requirements of AWS D1.4.

2.5 MISCELLANEOUS MATERIALS

A. Non-Shrink Grout shall be natural aggregate grout pre-mixed and bagged by manufacturer. Non-shrink grout shall conform to ASTM C 1107 Grade B or C when tested at a fluid consistency of less than 30 seconds per ASTM C 939 at temperature extremes of 40°F and 90°F (7°C and 32°C) and an extended working time of 30 minutes. The corresponding minimum compressive strength of the grout at 28 days, based on ASTM C 942, shall be 7500 psi. The grout shall exhibit no measurable bleed when tested in accordance with ASTM C 940.

1. Sure-Grip High Performance Grout, by Dayton Superior.
2. Hi-Flow Grout, by Euclid Chemical Co.
3. Five Star Fluid Grout 100, by Five Star.
4. Masterflow 928 Grout, by MBT Technologies and Repair.
5. Other where accepted.

B. Epoxy Grout shall be non-shrink, 100% solids, 3-component, moisture tolerant grout.

1. E3-F, by Euclid Chemical Co.
2. Five Star Epoxy Grout, by Five Star.

3. Masterflow 648 CP, by MBT Technologies and Repair.
4. Sikadur 42, by Sika Corp.
5. Other where accepted.

C. Bonding Admixture shall be Latex type, non-redispersable, modified sand cement mortar conforming to ASTM C 1059, Type II.

1. Day-Chem Ad Bond, by Dayton Superior Corp.
2. Flex-Con or SBR Latex, by Euclid Chemical Co.
3. Everbond, by L&M Construction Chemicals, Inc.
4. Strong Bond, or Sure Bond (EVA), by Symons Corp.
5. Other where accepted.

D. Epoxy Adhesive shall conform to ASTM C 881, and shall be a two-component, 100% solids material, suitable for use on both dry and wet surfaces. Acceptable materials:

1. Sure-Anchor Epoxy, by Dayton Superior Corp.
2. Dural #452 Series or Duralprep AC, by Euclid Chemical Co.
3. Concresive Standard Paste LVI, by MBT Technologies and Repair.
4. Sikadur 32 Hi-Mod or Sikadur 32 Hi-Mod LPL, by Sika Corp.
5. Rezi-Weld 1000, by W.R. Meadows, Inc.
6. Other where accepted.

E. Polymer Repair Mortar: These patching mortars may be used when color match of the adjacent concrete is not required. Prior approval by the Structural Engineer is required.

1. Polyfast FS, by Dayton Superior.
2. Thin Top Supreme or Concrete Top Supreme (horizontal repairs), Verticoat or Verticoat Supreme (vertical and overhead repair),by Euclid Chemical Co.
3. Sikatop 121 & 122 (horizontal repair), Sikatop 123 (vertical and overhead repairs), by Sika Corp.
4. Other where accepted.

F. High Strength Flowing Repair Mortar for forming and pouring structural members, or large horizontal repairs, provide the flowable one-part, high strength microsilica modified repair mortar with 3/8" aggregate. The product shall achieve 9000 psi @ 28-days at a 9-inch slump.

1. Eurococrete, or Euco Speed MP (Cold Weather) by Euclid Chemical Co.
2. Polyfast LPL, by Dayton Superior.
3. Emaco S77 CI, by MBT Protection and Repair.
4. Other where accepted.

G. Fusion Bonded Epoxy Coating shall conform to ASTM A 775. Acceptable manufacturer is ScotchKote 413 by 3M, or other where accepted.

H. Patching Material for Epoxy Coated Reinforcement shall be ScotchKote 413/215 PC Patch Compound by 3M or other accepted patch material.

I. Drill-In Anchors shall be wedge-type. Capsule-type will not be permitted. Drill-in anchors shall be standard wedge-type unless otherwise noted. Drill-in anchors designated in the Drawings as carrying a direct tensile load shall be undercut wedge-type.

1. Standard Wedge-Type Anchors:
   a) DFS Wedge Anchor, by Diversified Fastening Systems Inc.
   b) Kwik Bolt III and TZ, by Hilti Corp.
   c) Trubolt Wedge, by ITW Ramset/Red Head.
   d) Power-Stud, by Powers Fasteners Inc.
   e) Other where accepted

2. Torque Controlled Wedge-Type Anchors:
   a) HSL III Heavy Duty Sleeve Anchor, by Hilti Corp.
   b) Wedge Anchor BoA-K, by Liebig Safety Bolts.
   c) Power-Bolt, by Powers Fasteners Inc.
   d) R1S or R7S Spin-Lock Anchors, by Williams Form Engineering Corp.
   e) Other where accepted

   Material for standard and torque controlled wedge-type anchors shall conform to ASTM A 325, F-S-325 Group II or SAE-J429 Grade 5 with nuts and washers as specified herein for A325 bolts.

3. Undercut Wedge-Type Anchors:
   a) Maxi-Bolt, by Drillco National Group.
   b) HDA Undercut Anchor, by Hilti Corp.
   c) Ultraplus, by Liebig Safety Bolts.
   d) S-9 Undercut Anchor, by Williams Form Engineering Corp.
   e) Other where accepted

   Material for undercut-type anchors shall conform to ASTM A 193 Grade B7 or ISO 898 Class 8.8 with nuts and washers as specified herein for A325 bolts.

4. Galvanizing shall conform to ASTM B 695, Class 50 or to ASTM B 633, SC1.

5. Stainless steel for studs and washers shall conform to AISI Grade 304 or Grade 316 and to ASTM F 593, Group 1 or Group 2, Condition SH. Nuts shall be of stainless steel conforming to ASTM F 594, Group 1 or Group 2, Condition SH.

J. **Expansion Dowels** shall be ASTM A 36 bars or equivalent, hot-dip galvanized, of the size and spacing given in the Drawings, and shall be provided with a suitable expansion shield securely positioned and end filled by readily compressible material assuring adequate expansion space beyond the free end of the dowel.

1. Acceptable Expansion Dowel Basket Assemblies for use in Slab-on-Ground Contraction Joints: Load Plate Basket Assembly by PNA Construction Technologies or other accepted.

2. Acceptable Expansion Diamond-Shaped Load Plates for use in Construction Joints: Diamond Dowel System by PNA Construction Technologies or other accepted.

K. Joint Filler:

1. Unless otherwise noted, use non-staining, non-extruding, compressible and resilient joint filler of sponge rubber conforming to ASTM D 1752, Type I. Joint fillers which contain or have been treated with oil, grease or bituminous materials are prohibited. Test joint fillers for compatibility with proposed primers and sealants ♣as specified in Section 07 90 00.
2. Acceptable preformed joint filler: FF-3 Sponge Rubber, by Progress Unlimited, Inc.; Cementone Sponge Rubber, by Tamms Industries; or other accepted filler.
3. Provide compatible joint sealing compound: ♣See Specification Section 07 92 00.

L. Compressible Filler where required under slab on grade: 2 or more layers of geotextile material to provide a minimum 1" (25 mm) thickness after concrete slab is in place. Accepted material: CCW-Miradrain 6000/6200, by Carlisle-CCW Inc. or other accepted material.

M. Cellular Glass shall be 100 percent inorganic closed-cell glass with 100 psi (700 kPa) compressive strength, 8 pcf (128 kg/cubic meter) density, incombustible, and possess a water vapor permeability not exceeding 0.005 perm-in. Provide adhesive for joining units as applicable and as accepted. Acceptable cellular glass insulation: Foamglas HLB 800, by Pittsburgh Corning, or other accepted cellular glass.

N. Cellular Polystyrene shall conform to ASTM C 578, Type IV or better and shall be sufficiently hard and dense and/or shall be sealed so as to preclude completely the dispersing of Styrofoam particles into the plastic concrete. Acceptable cellular polystyrene: Styrofoam Cavitymate Plus, by The Dow Chemical Co., or other acceptable cellular polystyrene.

O. Bond Breaker shall be 4 mil (100 µm) thick polyethylene sheet.

P. Moisture-Retaining Cover Conforming to ASTM C171: A naturally colored, non-woven polypropylene fabric with a 4-mil non-perforated reflective (white) polyethylene coating containing stablizers to resist degradation from ultraviolet light. Acceptable Moisture-Retaining Cover: Hydracure S-16 by PNA Construction or Transguard 4000 by Beef Industries.

Q. **Vapor Barrier** for slab-on-ground shall conform to ASTM E1745, Class B. The vapor barrier shall be placed over prepared base material where indicated below slabs on grade. Lap sealant shall be the manufacturer's recommended bonding material.
1. Moistop Ultra (15 mil) by Fortifiber Corp.
2. Stego Wrap (15 mil) Vapor Barrier by Stego Industries LLC.
3. Perminator Vapor-Mat (15 mil),, by W.R. Meadows, Inc.
4. Vapor Block 15, by Raven Industries.
5. Other accepted barrier.

R. **Crushed Stone:**

1. Under slabs-on-ground shall consist of clean, hard, durable, natural rock, free of organic matter, rock dust and other contaminants, and shall be well graded within the requirements of ASTM C 33, Size #467.

a) Material conforming to AASHTO Specification M80 will be accepted for use in the Work.

S. Pachometer (reinforcing bar locator): Use James R-Meter by James Instruments or other accepted pachometer.

2.6 SURFACE TREATMENTS

These products are compliant with the requirements of Ozone Transport Commission (OTC), which includes NY and NJ, of a maximum 350 g/l VOC limit.

A. Clear Curing and Sealing Compound VOC Compliant, 350 g/l, shall be a liquid type membrane-forming curing compound, complying with ASTM C 1315, Type I, Class A, 25% solids content minimum. Moisture loss shall be not more than 0.40 kg/m2 when applied at 300 sq. ft./gal. Compound shall be compatible with all subsequent finishes and toppings, shall chemically combine fully with the concrete in 30 days or less, shall leave no surface residue, and shall preclude secondary reactions within concrete as well as materials applied to the concrete surface. Manufacturer's certification is required. Subject to project requirements, provide one of the following products:

1. Super Diamond Clear VOX, by Euclid Chemical Co.
2. Lumiseal WB Plus, by L&M Construction Chemicals, Inc.
3. Kure 1315, by Sonneborn Products.
4. Other where accepted.

B. Dissipating/Non-residue Forming (Strippable) Curing Compound (VOC Compliant, 350 g/l) shall be a liquid membrane-forming compound conforming to ASTM C 309, Type 1 or 1-D that chemically breaks down and wears off after curing is complete. Install in strict accordance with the manufacturer's recommendations. Manufacturer's certification is required.

1. Kurez DR VOX, by Euclid Chemical Co.
2. L&M Cure R, by L&M Construction Chemicals, Inc.
3. Kure-N-Harden, by Sonneborn Products.
4. 1100-Clear Series, by W. R. Meadows, Inc.
5. Other where accepted.

C. Evaporation Retarder/Finishing Aid:

1. Eucobar, by Euclid Chemical Co.
2. E-Con, by L&M Construction Chemical, Inc.
3. Confilm, by MBT Protection and Repair.
4. SikaFilm, by Sika Corp.
5. Other where accepted.

D. Surface Retarder:

1. A-H Retard Set, by Anti-Hydro International, Inc.
2. True Etch Surface Retarder, by Burke.
3. Concrete Surface Retarders, by Euclid Chemical Co.
4. Rugasol-S, by Sika Corp.
5. Other where accepted.

E. Liquid Densifier/Sealer: The liquid densifier compound shall be a siliconate based sealer which penetrates concrete surfaces, increases abrasion resistance and provides a “low-sheen” surface that is easy to clean and eases the problem of tire mark removal. The compound need contain a minimum solids content of 20%, of which 50% is siliconate.

1. Euco Diamond Hard, by Euclid Chemical Co.
2. Ashford Formula, by Curecrete Chemical Co., Inc.
3. Seal Hard, by L & M Construction Chemicals, Inc.

F. Non-Oxidizing Metallic Hardener: The specified non-oxidizing metallic floor hardener shall be formulated, processed and packaged under stringent quality control at the manufacturer’s owned and controlled factory. The hardener shall be a mixture of specially processed non-rusting aggregate, selected Portland cement and necessary plasticizing agents. Product shall be “Diamond-Plate” by Euclid Chemical Co. or other were accepted.

G. Concrete Cleaning/Finishing Solution: General surface cleaner shall be a commercial concrete cleaner containing solvents, stain removers, detergents and a maximum of 2 percent chloride acid. Accepted cleaner: Light Duty Concrete Cleaner by ProSoCo, Inc., or other accepted compound.

PART 3 - EXECUTION

3.1 CONTRACTOR'S INSPECTION

A. Examination of Field Conditions: Examine all surfaces, features and facilities to which Work must be attached or applied, abut or clear. Notify Construction Manager and Architect in writing of all conditions which are or will be detrimental to proper and expeditious installation of Work. Starting of Work shall represent acceptance by Contractor of surfaces and of conditions as suitable and correct for performing Work as specified.

B. Field Measurements: Contractor shall verify, by measurements at the job site, all dimensions affecting the Work of this Section. Field dimensions at variance with those in accepted Shop Drawings shall be reported in writing by Contractor. Decisions regarding corrective measures shall be subject to acceptance and acceptance shall be obtained before starting fabrication of items affected. The starting of Work shall represent acceptance by Contractor of all dimensions affecting the Work of this Section as suitable and correct for the performing of all Work under this Section.

3.2 FORMWORK

A. Reference Standards: Formwork shall conform to ACI 347R, except where more stringent requirements are given in the Drawings or in this Specification.

B. General: Contractor shall be solely responsible for the design, engineering, construction, completeness, safety and adequacy of all concrete formwork. Provide removable formwork for all concrete not indicated specifically to be formed by other means. Provide for anchorages and inserts, blocking, bulkheads, chamfers, keys and keyways, ledges, moldings, offsets, openings, recesses, reglets, screeds and all else to complete the Work.

1. Formwork shall be designed and constructed to withstand all forces imposed upon the formwork including all construction dead and live loads, horizontal loads from equipment, wind and earthquake forces, and forces due to vibration of plastic concrete. Shoring shall be adequate in strength and in position so that loads of successive parts of the structure will be transmitted directly through the falsework without the creation of shearing or bending stresses in the concrete Work. Shoring shall not bear on slabs on ground until such concrete has attained design strength and only where the slab-on-ground is able to accept the imposed loads without distress.

2. Formwork shall be tight to prevent leakage of mortar from the concrete so as to provide concrete free of honeycombs, shall be of adequate rigidity and strength, and shall be adequately braced to produce true lines, free of bulges and unsightly depressions, to accurate elevations and correct alignments. Joints between form face edges shall be tight and strongly backed to provide joints that are flush and true. Provide inspection of all formwork for conformance with this Specification and with form drawing design, both prior to, during and after concreting.

3. Fabricate for easy removal, without prying or hammering against concrete surfaces. Provide crush or working plates where stripping may damage concrete surfaces.

C. Construction and Erection of Forms:

1. Build into formwork positive means of adjustment (wedges, jacks and the like) of shores and struts and take out all settlements during concrete placement operations. Brace forms securely against lateral forces and to prevent lateral deflections.

2. Build into the formwork and otherwise make necessary provisions in formwork to accommodate the Work of other Sections of this Specification. Obtain required information and materials from affected trades. Install inserts, sleeves, edge and corner angles, steel frames and the like securely in the formwork to allow sound embedment of their anchorage devices, without displacement, and to provide the required alignment to the formed and finished concrete faces and surfaces. Provide boxouts for items to be provided at a later date. Seal, or fill with readily removable filler all voids in embedded items and sleeves in order to prevent complete or partial filling by intrusion of concrete paste.
3. Provide material with sufficient thickness so that newly placed concrete does not bow, distort or deflect formwork.
4. Concrete Surfaces Not Exposed to View: Contractor may use plywood, lumber, metal and other materials included under this Specification.
5. Reuse of Form Material: Clean thoroughly and repair forming materials prior to reuse. Damaged material which cannot be properly reconditioned to produce Work conforming to this Specification shall be discarded. Formwork may be reused only the number of times which will assure that concrete surfaces produced will meet the provisions of this Specification. Condition of formwork and use or reuse of formwork shall be subject to acceptance. Formwork for architectural concrete which cannot be tightly butted and made mortar-tight shall not be reused. Where reuse of forms is permitted or accepted, withdraw all nails, clean forms, and repair damaged surfaces by replacement of damaged boards or units. Formwork materials rejected shall be removed promptly from the site.
6. Clean-Out and Access Panels: Provide readily removable and securely replaceable panels in column forms, wall forms, and other types of formwork as needed to permit ready access for cleaning formwork totally free from standing water, dust, dirt and other debris, allow inspection of condition of formwork, reinforcement, and concrete bonding surfaces, and as needed to allow proper access for concrete placement and vibration. Locate removable panels to minimize exposure to view, except where more exposed locations are accepted.
7. Protect Soft Materials such as Styrofoam from contact by vibrators and other equipment. Evidence of dispersion of such materials into concrete will be considered as evidence for rejection of that concrete.

D. Cellular Glass and Cellular Polystyrene panels shall be installed with staggered joints and shall be bonded with adhesives recommended by the manufacturer.

E. Form Release Treatment: Clean and treat all removable forms with form release agent prior to placing reinforcement and embedded items. Remove excess form release agent and do not allow agent to come in contact with previously placed concrete or reinforcing steel.

F. Clean and Tighten all forms immediately prior to casting concrete. Retighten formwork after placing concrete to account for concrete shrinkage and the like and to minimize mortar leakage.

G. Horizontal and Sloped Concrete Surfaces below finish grade which will not be exposed to view, where permitted and where shown in Drawings, may be formed by the use of clean cut trenches in lieu of forms.

1. Provide 3 inches (75 mm) minimum cover to reinforcement at all surfaces formed by earth, rock, or geotextile fabric.
2. Provide vapor barrier liner at all surfaces composed of uncemented granular materials, geotextile fabric and other materials which readily absorb water.

3.3 FABRICATION AND PLACEMENT OF REINFORCEMENT

A. Reinforcing Steel shall be Shop Fabricated in strict accord with the Shop Drawings, certificates, and other submitted and accepted data. All Work shall conform to the applicable Standards as given herein and as need apply to the Work. Workmanship shall be of the best practice of relevant trades and shall be performed by skilled mechanics making use of modern tools and equipment which are in good condition. To the extent practical, Work shall be accomplished in the shop and not in the field.

B. Reinforcing Steel, whether existing or provided under this contract, shall be free from paint, oil, dirt, scale, ice, frost, loose rust, grease, clay or other soil, and other substances or coatings which could reduce bond with concrete.

C. Placing Reinforcing Steel: Comply with the more severe of ACI, CRSI, *Building Code* and this Specification.

D. Reinforcing Bar Supports shall be appropriate to the intended use, of sufficient number, spacing, rigidity and strength to prevent displacement of reinforcing and to hold reinforcing accurately in correct position both before and during concrete placement. Do not place reinforcing bars more than 2 inches (50 mm) beyond the last leg of continuous bar supports. Do not use bar supports as support for runways, conveying equipment or for any purpose other than for supporting reinforcing bars.

1. For concrete surfaces not exposed to view, use plastic or hot-dip galvanized supports.
2. For slab on ground, use chairs with base plates.
3. Securely tie and support reinforcement to prevent displacement by construction traffic and casting of concrete. Neither top nor bottom bars shall be allowed to sag below tolerances specified by Building Code or required by the Contract Documents. Concrete cover shall be uniformly maintained. Displacement of reinforcing steel and embedded items shall be corrected immediately and additional supports provided to prevent recurrence. Conform explicitly to Article 7.6, ACI 318. Separate adjacent layers of parallel bars with short lengths of #8 (25 mm) rebars placed transverse to and securely tied to separated bars of #8 (25 mm) or smaller size; separator bars for #8 (25 mm) and larger bars shall be of the largest bar size separated.

E. Tie Wires, where applicable, shall be tied to and bent behind bars in such a manner that concrete placement will not force the wire ends toward the exposed concrete surfaces. At exposed concrete surfaces, tie wire ends shall not fall within required clear concrete cover.

F. Wire Mesh: Lap deformed wire mesh reinforcement at all edges such that the overlap measured between the ends of each fabric sheet is not less than the larger of 8 inches (200 mm), the spacing of the cross wires plus 2 inches (50 mm) and 1.3 times the development length of the deformed wire, unless a larger lap is noted in the Drawings. Unless a larger lap is noted in the Drawings, lap plain wire mesh reinforcement at all edges such that the overlap measured between the outermost cross wires of each fabric sheet is not less than the larger of 6 inches (150 mm), the spacing of the cross wires plus 2 inches (50 mm), and 1.5 times the development length of plain wire. Provide and install in sheet lengths as long as is practical. Wire together adjacent sheets of mesh. Offset end laps not less than the width of the fabric sheet, precluding continuous end laps.

G. Tack Welding of reinforcing steel bars or mesh is prohibited. Reinforcement damaged by arc strikes or arc welding shall be replaced. Welding of reinforcing bar intersections is prohibited.

H. Welding and Flame Heating of reinforcing steel is prohibited unless performed in accord with appropriate qualified procedures and detail sketches prepared by Contractor and both submitted and accepted. Acceptance will be contingent on the following:

1. Use bars with proper metallurgy.
2. Follow explicitly AWS D1.4, including the qualifying of welders and welding procedures, prior to commencement of work.
3. Monitor preheat with Tempilstiks.
4. Provide proper protection to adjacent bars and concrete.
5. Each weld need be completed in a continuous operation, without stopping.
6. Cool slowly with insulating blankets.
7. Do not start welding on a bar until adjacent welds have cooled.
8. Remove damaged concrete on completion of all welds.
9. Properly bond, place and cure patch.

I. Coordination Detailing and Erection: Reinforcement shall be coordinated, detailed and erected to provide a clear passage for the positioning of tremie trunks in required locations. These openings shall be free of bars, bar ends, wire, ties, or obstructions which could hamper insertion and removal of the trunk.

J. Minimum Size WWF: Provide 6x6-W2xW2 WWF minimum in all concrete fill slabs except where heavier reinforcement is shown explicitly in the Drawings, except where fiber reinforcement is specified, and except for filling of metal pan treads and intermediate platforms which may be 2" x 2", 14 gauge (50 x 50 mm x 2100 µm), galvanized.

K. Reinforcing Bar Mechanical Connections shall be installed in accordance with ACI 439.3R and manufacturer's printed instructions.

L. Epoxy-Coated Reinforcement shall be subject to all applicable provisions of this Specification and, in addition, shall be subject to the following provisions:

1. Cold bend all bars around pins with nylon collars and take other steps required to minimize damage of the coating during fabrication. Hot bending will not be permitted.
2. Handling and hoisting shall be done with care, making use of nylon lifting slings. Bundles of reinforcement shall be lifted in a manner to prevent abrasions; spreaders shall be used to lift bundles where lifting at third points is not practical. Bundling bands shall be padded or shall be nylon.
3. Store epoxy-coated reinforcement on padded or wooden cribbing.
4. Reinforcing bars used as support bars for epoxy-coated reinforcement shall be epoxy-coated.
5. Field bending and field cutting of epoxy-coated reinforcement will not be permitted except where authorized expressly in writing.
6. Epoxy-coated reinforcement shall be saw cut; flame cutting is prohibited.
7. Damage to coating on bars exceeding 0.3 inches (8 mm) in any direction shall be repaired in accord with the patching material manufacturer's published instructions. Bars requiring patching in excess of 2 percent of the surface area of that bar shall be rejected and shall be removed immediately from the site.
8. All damage (i.e., 100%) to coating on weld wire fabric shall be repaired in accord with the patching material manufacturer's published instructions. Welded wire fabric requiring patching in excess of 1 percent of the surface area per linear foot of each wire shall be rejected and shall be removed immediately from the site.
9. Splicing of epoxy-coated bars shall be by lap-splice or by accepted mechanical couplers.

M. Concrete Anchors and Deformed Bar Anchors shall be installed in strict accord with the provisions of Section 05 30 00.

1. Where indicated in the Drawings, bend concrete anchors and deformed bar anchors in accordance with the requirements of the Drawings and of this Specification:
   a) Before automatic stud welding, cold bend concrete anchors and deformed bar anchors as required in accordance with the bend requirements given in the Contract Documents for concrete reinforcing bars of the same diameter. The use of heat to either bend or straighten concrete anchors is not permitted.
   b) Once bent, the shop straightening of either concrete anchors or deformed bar anchors is not permitted. The field straightening of bars that have been embedded in concrete is not permitted except where accepted specifically.

N. After-Set Inserts or Drill-In Anchors: At wall and slab surfaces to receive after-set inserts or drill-in anchors, with written acceptance, it may be possible to place reinforcing steel to clear the depth of the field penetration. Whether or not permission is obtained, Contractor shall not cut or damage reinforcing steel in setting of after-set inserts or drill-in anchors or for any other reason.

O. Lap Splices: Reinforcing bars may be lapped in contact splices wired together or by lap lengths separated by spacing shown or noted in the Shop Drawings or permitted by this Specification.

P. Straightening: Once bent, the shop straightening of reinforcing bars is not permitted. The field straightening of bars that have been embedded in concrete is permitted only where authorized specifically.

1. For field bending, acceptance will require generally that larger bars be heated to 1200°F (700°C) maximum and that concrete be protected by insulation blankets. After straightening, acceptance will require that bars be insulated and cooled slowly.

Q. Bundling of Reinforcement shall not be permitted except where detailed in the drawings or where accepted by Structural Engineer.

3.4 JOINTS

A. Construction Joints:

1. Construction joints shall be made and located so as to least impair the strength and appearance of the structure. Construction joints shall be made only at locations shown in the Contract Drawings or accepted specifically. Construction joints shall conform to the *Building Code* and to ACI 318, Article 6.4. Location of all construction joints not shown in the Drawings shall be submitted for acceptance.

a) All construction joints shall be keyed not less than 1-1/2 inches (40 mm) deep. Wood box-outs treated with a form release agent or cellular polystyrene box-outs shall be used for keying concrete; the chipping of keys after concrete placement as a construction methodology is prohibited. Continue all reinforcing steel across construction joints. Contractor shall supply, fabricate, and place additional reinforcing steel where location of construction joint in any way weakens the construction.

b) Horizontal construction joints will not be permitted in beams and slabs except where shown in the Drawings. Horizontal construction joints in walls will not be permitted except where shown in the Drawings or in accepted Shop Drawings.

c) Where terrazzo, pavers, stone or other overlay finishes are required, locate slab construction joints accurately at locations directly below expansion joints in the overlay material. Waiver of this requirement will not be given except that, for sand-bedded finishes, alternative proposals will be considered.

2. Spacing of Construction Joints: Conform to and do not exceed maximum distance between construction joints as shown or noted in the Drawings and in this Specification. Where no other restriction applies, provide construction joints at a spacing not greater than 33 feet (10 m) joint-to-joint in perimeter walls below grade; 65 feet (20 m) maximum joint-to-joint in perimeter walls above grade and all interior walls, above or below grade; 120 feet (36 m) maximum joint-to-joint and providing 10,000 square feet (836 square meters) maximum for slab pours; 20 feet (6 m) for sidewalks (in line with curb joints). In considering wall joints, a 90 degree corner may be considered a joint. Limitations on construction joint spacing do not apply to slabs on steel deck.

B. Construction Joints Not Located in Drawings:

C. Expansion Joints: Locate and construct as shown or noted in the Drawings. Do not continue reinforcement or conduit through expansion joints. Working width of expansion joints shall be kept free from all extraneous materials. Contractor shall take special care to assure that expansion joints are properly constructed, cleaned, and function properly. Joints shall be cleaned prior to removal of soffit formwork and shall be recleaned just prior to installing finish materials. Take particular care to remove wood, cellular polystyrene and other soft materials from such joints.

D. Joint Filler: Joint filler shall be installed where indicated in the Drawings. Joint filler shall be full depth of joint and shall be set flush with exposed concrete surface, except where sealant or a reveal is indicated, in which case the joint filler shall be set back as detailed in the Drawings.

3.5 EMBEDDED WORK

A. General: Locate, set and build into the Work such embedded items as are required by the Work of this Section and by the Work of other Sections and Divisions of this Specification.

1. All embedded items required for adjoining Work or for its support shall be placed prior to placing of concrete and, where practicable, prior to placing reinforcing steel.
2. All other trades whose Work is related to cast-in-place concrete Work or whose work must be supported by cast-in-place concrete shall be given ample notice and opportunity to install or furnish embedded items before the affected concrete is placed.
3. Obtain setting diagrams and instructions from the supplier of item to be set and follow instructions implicitly.
4. Provide templates, set accurately to line and to level by transit and/or by laser level and anchor securely so as to not displace during placing and compaction of concrete.
5. Seal, temporarily pack and protect inserts and sleeves from intrusion of concrete or concrete mortar during concrete placement operations.
6. Aluminum: No aluminum shall be embedded in or shall be installed in contact with concrete Work unless provided with an accepted protective coating.

B. Post-Installed Anchors shown in the Drawings, or accepted in writing, shall be installed in strict accord with Manufacturer's Printed Installation Instructions. Anchors may be placed in block or brick work only where voids within 9 inches (230 mm) of the anchor have been filled solidly, with grout. Set perpendicular to concrete surface. Drilled holes shall be cleaned thoroughly with compressed air or water jet.

C. Pipes and Conduit: Location and spacing of piping and of electrical conduit embedded in structural concrete shall conform to Contract Documents, accepted Shop Drawings, to ACI 318, and to *Building Cod*e. Do not place pipes or conduits in concrete Work except where shown in accepted Shop Drawings.

3.6 NOT USED

3.7 NOT USED

3.8 CONCRETE VOLUME

A. General: Contractor shall provide all concrete volume necessary to accommodate deflection and settlement of formwork, and all other construction influences on the actual volume of concrete placed.

1. The design, installation and removal of shores is Contractor's responsibility.

2. Where over-excavation is required under footings (see Section 02 20 00), Contractor may be required to thicken the footings by the amount of the over-excavation while maintaining the top of footing elevation. Costs for such additional concrete and additional reinforcing steel, both of which are not a result of an error or non-compliance to Contract Documents by Contractor, shall be paid for on the basis of contract bid unit prices.

3.9 SLABS-ON-GROUND

A. **Codes:** Slabs-on-ground shall be constructed in accordance with ACI 302.1R *Guide for Concrete Floor and Slab Construction* and ACI 360R *Design of Slabs on Grade.*

B. **Porous Fill**: Work under this Section includes furnishing, placing and compacting of crushed stone under all slabs-on-ground. The porous fill shall be a total of 6 inches (150 mm) thick, crushed stone, unless otherwise shown in the Drawings, and shall be reasonably level.

1. Crushed stone shall be compacted in 6 inch (150 mm) maximum lifts using not less than four passes of a Wacker Vibratory Plate compactor or equivalent of sufficient capacity to achieve maximum density of the compacted porous fill.

2. The top of the compacted porous fill shall be not higher than the theoretical elevation taken from the Drawings.

C. **Vapor Barrier:** Provide over crushed stone. Overlap at joints and bond together with continuous lines of mastic, adhesive or tape in strict accord with manufacturer's printed instructions and ASTM E1643. Repair all punctures and tears just prior to pouring slab and maintain watertightness.

D. **Piping**, floor drains, electrical conduit and other items which are scheduled to be placed in the compacted fill shall be properly placed and tested by Contractor and accepted prior to the placement of the vapor barrier.

E. **Support Reinforcement** securely, on chairs with base plates or with precast concrete blocks, all as specified herein, or use other methods described in Shop Drawings and accepted.

F. **Subgrade:** Immediately prior to placing concrete; wet subgrade thoroughly.

3.10 MIXING AND DELIVERY OF CONCRETE

A. Ready-Mixed Concrete: All concrete shall be ready-mixed concrete. Measure, mix and deliver in accordance with ANSI/ASTM C 94, *Specification for* Ready-*Mixed Concrete*, and ACI 304R, Chapters 2, 3, 4, and 5 *Guide for Measuring, Mixing, Transporting and Placing Concrete*.

1. Plant equipment and facilities shall conform to the Check List Certification of Ready-Mix Concrete Production Facilities of the National Ready Mixed Concrete Association.

2. Ready mix equipment shall be completely automated.
   a) Computerized batch/truck ticket printouts shall be delivered to the Owner or Owner's inspection agency at time of concrete delivery to job site.

3. Provide site equipment in sufficient time to permit inspection, calibration, adjustment and repair as may be required before start of concrete Work.

4. Admixtures shall be measured and inserted into the mix at the plant except where written exceptions are obtained. The concrete producer shall provide a redosage chart for the high range admixture. This procedure assures a slump or slump flow is in the approved envelope.

5. If accepted by Structural Engineer, subject to the following conditions, water and/or admixtures may be added to the concrete at the site:
   a) Water shall not be added during transit, on site, or during placement to self-consolidating concrete.
   b) Design mixes indicate water and/or admixtures to be added at the site.
   c) Batch/truck tickets indicate the maximum amount of water and/or admixtures that can be added without exceeding the maximum specified water/cementitious ratio or admixture dosage.
   d) Water and/or admixtures are added in a manner to control volume.
   e) Concrete is properly remixed after addition of water and/or admixtures.
   f) Dosage and time of addition at the site are reported on batch/truck tickets and signed by Contractor's site quality control supervisor.

B. Hand-Mixed Concrete shall be used only where accepted specifically. Such concrete shall be mixed only in watertight containers, with dry materials measured by loose volume, sand and cement mixed together dry prior to adding coarse aggregate. Water, when added, shall be applied slowly with the entire mass turned to provide for an even mixture at all times.

C. Hot and Cold Weather: Comply with ACI 305 for hot weather and with ACI 306 for cold weather concreting.

1. Where air temperature is between 85°F (30°C) and 90°F (32°C), reduce the mixing and delivery time from 1-1/2 hours to 1-1/4 hours; where air temperature exceeds 90°F (32°C), reduce mixing and delivery time to 60 minutes.

2. Where air temperature is below 40°F (4°C), uniformly heat both water and aggregates to obtain a concrete mixture with a temperature both above 50°F (10°C) and below 80°F (27°C) at all times of mixing, transportation and placement.

3. Use accelerating admixture in concrete for slabs placed at ambient temperatures below 50°F (10°C).
4. Freeze resistant concrete design mixes are acceptable for use provided they have been submitted and approved prior.
5. Self-consolidating concrete placement shall be prohibited during cold weather conditions as defined in ACI 306, *Cold Weather Concreting*.
6. Self-consolidating concrete placement shall be prohibited during hot weather conditions as defined in ACI 305, *Hot Weather Concreting*.

D. Cement: At its own expense, Contractor will be required to test or to retest cements which may be contributing to nonconforming concrete, may have been damaged in transit or storage or may have been retained at mixing plant for 30 days or longer.

3.11 PLACING CONCRETE

A. Codes: Concrete shall be placed in accordance with ACI 304R, *Guide for Measuring, Mixing, Transporting and Placing Concrete*, and shall be handled with due care to prevent deterioration due to delay or handling. Concrete shall be consolidated in accordance with ACI 309R.

B. Clean Reinforcement, whether existing, previously placed, or placed for the pour, to a condition not less clean than is required by this Specification, including referenced, cited and stipulated Codes and Standards.

C. Clean and Seal Formwork: Formwork shall be clean and free from frost, papers, sawdust, dirt and debris immediately prior to and during the time concrete is placed thereon.

D. Concrete Pumping: Subject to the provisions of this Specification, ACI 304R - Chapter 9 and ACI 304.2R, concrete may be conveyed and placed by pumping. Concrete shall be pumped through lines 5 inches (125 mm) in diameter or larger. Pumped concrete mix should provide the maximum practicable coarse aggregate content. Lightweight aggregate, where proposed for pumping, shall contain optimum moisture content for pumping, but not less than 16 percent absorbed moisture, based on the oven-dry weight of the lightweight aggregate. Pump lines shall be properly lubricated per ACI 304.2 prior to commencement of concrete placement.

E. Slump and Slump-Flow: Concrete with slump or slump-flow exceeding the limits specified herein shall not be placed in the Work. Concrete with excessive slump shall be removed immediately from the site or may be used as lean concrete.

F. Conveying of Concrete: This Specification contemplates movement of fresh concrete from the point of receipt to the location of final deposit by concrete pumps, chutes, concrete bucket, pneumatic-tired buggies and combinations of the foregoing methods. Canvas or rubber "elephant trunks" of appropriate lengths shall be used to limit free fall of concrete. Chutes shall not be used to transport concrete for distances in excess of 30 feet (9 m) nor shall chutes be sloped greater than 1 vertical to 2 horizontal. Baffle plates shall be provided and other means shall be taken to prevent segregation. All devices used for conveying concrete shall be watertight, shall not allow concrete to come in contact with uncoated aluminum or with aluminum alloys and shall be cleaned thoroughly prior to use.

G. Protect Formwork from damage by conveying equipment and systems.

H. Clean, Tighten, Soak and Bonding Compound: Prior to placing fresh concrete, retighten forms against previously placed concrete. Existing and previously cast concrete surfaces shall be first cleaned of laitance and deleterious materials, the surfaces shall be then roughened so as to remove all loose or damaged material that may be present. Finally, concrete surfaces shall be soaked with water. Standing water shall be removed. In addition to soaking with water, apply the specified bonding compound within a 24 open hour time frame in accordance with manufacturer's printed instructions to the following:

1. Vertical surfaces along slab-to-slab, slab-to-wall, and beam-to-beam joints.
2. Horizontal surfaces along slab-to-wall joints.
3. Other surfaces where indicated in the Drawings.

Contractors procedures shall recognize that substantial shearing stresses in the horizontal plane are carried across most construction joints.

I. Coordination of Concrete Placement: The batch plant, transit, conveying and placing operations shall be coordinated so that all concrete is in its final position within 1-1/2 hours from the time the mix is charged with water. Do not place concrete warmer than 90°F (32°C) except as provided in this Specification; for Architectural Concrete, the acceptable temperature of deposited concrete shall be between 50°F (10°C) and 86°F (30°C); for slab-on-ground concrete, the acceptable temperature of deposited concrete shall be between 50°F (10°C) and 70°F (21°C). The batching plant shall either provide chilled batch water or substitute crushed ice for part of the mixing water if required to satisfy specified concrete placing temperatures. Coordination shall be performed so that every deposit placed in the forms shall be covered by a subsequent deposit and consolidated within 15 minutes and in a continuous manner. Truck delivery, truck charging, crane positions, bucket size, tremie numbers and locations, lift heights, etc., shall be planned and directed toward achieving homogeneous and consistent placements.

J. Placement of Concrete: Do not begin until all reinforcing has been placed, secured, and inspected. Partially hardened or retempered concrete shall not be used in the Work. Concrete placement shall be carried out in a continuous manner between construction joints and at such a rate that freshly deposited concrete may be uniformly integrated and made homogeneous at all contact surfaces with preceding deposits of concrete which shall remain both plastic and properly workable by vibration.

1. Placement of concrete elements supported by columns, walls, piers and the like, shall not commence until the supporting concrete is no longer plastic and, in any event, not before a 4 hour waiting period is fully expired.

2. Concrete shall be deposited as near as practicable and possible to its final position in the structure. Placement procedures shall avoid segregation due to rehandling or due to the lateral flowing of concrete induced by gravity or by vertical dropping. To minimize segregation, concrete may not be dropped between reinforcing steel curtains and cages, nor through successive reinforcement grids. Without special acceptance, vertical free fall of concrete shall be limited to 4 feet (1200 mm).

3. Procedures which cause or contribute to excessive segregation of aggregates or cause non-uniform concrete mixtures shall not be used and will be rejected.

4. Place concrete at slumps and using procedures which will produce a homogeneous, properly compacted concrete with uniform finished surfaces.

5. Concrete shall not be placed onto or under water except where permitted specifically by the Drawings or by this Specification.

K. Cold Joints are defined as joints wherein concrete on one side has hardened sufficiently so that fresh concrete does not mix thoroughly with that concrete. Cold joints, should they occur, shall result in the immediate stoppage of all placement operations. Detailed drawings showing remedial measures, including removal of material, the drilling-in of dowels and anchors, the construction of keys and specially roughened construction joints by bush hammering and all else will be required prior to placing contiguous concrete.

L. Layering: Concrete may not be placed in layers exceeding 2 feet (600 mm) in depth. Each layer shall be vibrated to the extent necessary to remove voids, honeycombing and the like.

M. Vibration: In accordance with ACI 309R, with the exception of self-consolidating concrete shall be compacted thoroughly by vibrating to produce a dense, homogeneous mass without voids or pockets and shall be accomplished only by experienced operators. Internal vibrators shall be placed in the concrete vertically and shall penetrate at least 3 to 4 inches (75 to 100 mm) into the preceding lift in order to thoroughly blend adjacent layers. Vibrating techniques shall assure that the matrix is thoroughly and uniformly distributed around all coarse aggregate, including at form faces, thereby providing uniform dense concrete throughout the entire concrete volume. Vibration shall not be used as a means of transporting concrete. Following top-out leveling of exposed columns, walls and spandrels, concrete shall be allowed to set for 10 to 15 minutes, and shall then be given a final vibration and compaction, 1'-0" (300 mm) deep. Work concrete thoroughly around waterstops and other embedded items.

1. Where vibrating concrete with epoxy coated reinforcement, provide vibrators with rubber covered heads and otherwise preclude damage to the epoxy coating.

N. Pinholes: Voids or holes larger than 1/4 inch (6 mm) in largest dimension shall be repaired under the provisions of this Section.

O. Epoxy Injection: Place concrete at a slump and consistency which will result in dense, waterproof in-place concrete without shrinkage cracks. Should cracking occur, repair by epoxy pressure injection using an accepted injection procedure and low viscosity, 100% solids, moisture insensitive, non-shrink, two-component epoxy.

P. Superplasticized Concrete: Note that hydraulic pressures against formwork may be increased substantially with the use of a HRWR and with self-consolidating concrete. Use at all locations where concrete will not flow readily around embedded reinforcement and/or other items, at locations given in the Drawings or in this Specification, at all locations where sulfate resistance is required, and as follows:

1. Use for all concrete with a water cementitious ratio below 0.50.

Q. Pea Gravel Concrete: Use where specified in the drawings and at all areas of heavy reinforcing steel congestion where 3/4" (20 mm) aggregate concrete either results in honey combing or will not readily flow into position. Use in all wall sections 6 inches (150 mm) thick or thinner and to fill the pans of steel pan stairs.

R. Slopes to Drains: Lay out screed lines and finish top of concrete surfaces to provide sloped surfaces as shown in the Drawings and as required to produce free-draining surfaces.

3.12 NOT USED

3.13 OTHER CONCRETE WORK

A. Concrete Fill for Mechanical and Electrical Equipment: Concrete fill shall be normal weight concrete, f'c = 4000 psi (28 MPa). Reinforced concrete fill with welded steel wire fabric, 2" x 2" by 14 gauge (50 x 50 mm, 2100 µm), layered 9" (240 mm) o.c. vertically, but not less than one layer set midway in fill. Roughen surface of base slab, clean thoroughly and water soak for 12 hours or more prior to placing concrete fill. Set anchor bolts for securing mechanical and electrical equipment prior to placing concrete fill, locate accurately and hold secure by templates. Trowel concrete fill to a dense, smooth finish.

B. Cement Grout:

1. Grout items indicated in the Drawings. Grout openings in concrete around conduit, piping and other Work passing through concrete except where non-shrink grout is specified or shown. Mix, place and cure as provided by this Specification.
2. Drypack grout at beam pockets in concrete walls as shown in the Drawings. Pack grout solidly, fill entire area to be grouted, and provide complete bearing with no voids. Cure for seven days.
3. Where required herein or by the Drawings, fill form tie holes with grout matching surrounding concrete color. Cure for seven days.

C. Non-Shrink Grouting: Provide formwork for grouting, install flowable non-shrink grout, cure, remove grout forms and seal and protect exposed grout edges, all in strict accord with the printed instructions of the grout manufacturer.

D. Curbs: Strip formwork while still green and steel-trowel surfaces to a hard, dense finish. Provide corners, intersections and terminations that are slightly rounded.

E. Cement Bases shall consist of one part Portland cement and 2 parts fine aggregate.

1. Clean and roughen backing, brush in pure cement grout, place with accurate screeds, trowel to a dense, smooth finish with a bullnosed top. Provide cove at intersections with floor.

F. Topping Slabs shall be normal weight, 4000 psi (28 MPa), unless given otherwise in the Drawings or in this Specification.

1. Clean surfaces under topping slab of all oil, debris, laitance and other material which could reduce bond between the topping slab and the underlying materials. Moisten thoroughly, where surface is concrete; do not leave standing water.
2. Place 4 mil (250 µm) or thicker polyethylene slip sheet over all surfaces which are not concrete. Then place 10 mil slip sheet over the lower 4 mil slip sheet. Lap and seal slip sheet used as a vapor barrier. Take all precautions needed to protect waterproofing systems and other underlying materials.

3. Reinforce with 6x6 - W2.9 x W2.9 welded wire fabric except where heavier reinforcement is given in the Drawings. Maximum shrinkage shall be less than 0.02% at 28 days.

4. Convey and place so as to secure positive compaction and consolidation of topping slab, resulting in uniform, homogeneous concrete, free from segregation. Provide and use appropriate vibrating screeds.

5. Finish Cure and Seal in accord with the requirements contained in the Drawings and in this Specification.

3.14 CONCRETE FINISHES AND TREATMENTS

A. General: Bring surface to level with screeds and strike off. Smooth the resulting surface with bull floats or darbies to remove both high points and low points. Do not add water to or disturb the plastic surface prior to finishing. Accomplish all finishes in accord with ACI 301, except where more stringent requirements are given in this Specification.

1. Unless otherwise provided under this Specification, all flatwork shall receive a monolithic steel troweled concrete finish.

2. Where finished floor is located above the top of the structural slab, provide all required fill and cement finish required to bring floor to final grade or to underside of final finish, as appropriate.

B. Flatwork Finishes: Apply the following finish types as required by the Drawings and by this Specification:

1. Float Finish: Required for concrete flatwork surfaces which will receive trowel finish, roofing, waterproofing membrane, insulation, sand-bedded terrazzo and similar finishes, composition troweled floor finish, or "floating slabs". After the concrete has been placed, struck off, consolidated and leveled, the concrete shall not be worked further until ready for floating. Floating shall begin when the water sheen has disappeared and/or when the mix has stiffened sufficiently to permit the proper operation of a power-driven float. The surface shall then be consolidated with power-driven floats. Hand floating with wood or cork faced floats shall be used in locations inaccessible to the power-driven machine. Immediately after leveling, the surface shall be refloated to uniform, smooth, granular texture. Wet cure for seven days.

2. Troweled Finish: Required for all concrete flatwork surfaces which will be exposed, or which will receive resilient flooring, carpeting, thin-set floor covering, paint and other thin-film finishes, waterproofing and roofing systems, and any other floor covering requiring a smooth base slab. First, achieve a float finish, and then:

a) After the concrete has been placed, struck off, consolidated, screeded and floated, and as soon as the condition of the slab permits, and before it has hardened appreciably, all water film and foreign material which may work to the surface shall be removed by means of lutes.

b) Prior to removal of screed, the surface shall be checked for flatness and levelness, and filled or cut down where necessary. Rough finishing shall be repeated with straightedge and float.
c) The surface shall be troweled at least twice to a smooth dense finish.
d) The first troweling after power floating shall be done by a power trowel and shall produce a smooth surface which is relatively free of defects but which may still contain some trowel marks.
e) Where required, additional troweling shall be done after the surface has hardened sufficiently. The finished surface shall be dense and smooth, free of any trowel marks, uniform in texture and appearance. On surfaces intended to receive floor covering, defects that would show through the floor covering shall be removed by grinding.
f) Concrete surfaces to receive membrane waterproofing shall receive a trowel finish which leaves the surface smooth and dense, free of voids, projections or ridges.
g) These surfaces shall be wet cured for seven days, unless a strippable curing compound is used.

3. Exposed Float Finish: Required for interior and exterior paving, where indicated in the Drawings, and for the tops of all exposed walls. Use "troweled finish" with a wood or cork float. Wet cure for seven days.

4. Scratched Finish: Required for concrete flatwork surfaces which will receive concrete or cement fill or which will receive finish material which will be bonded with cement mortar. After the concrete has been placed, struck off, consolidated and leveled, the surface shall be roughened with stiff brushes or rakes before final set. Wet cure for seven days.

C. Floors: Thoroughly clean all waste material from floors as soon as each segment of Work is completed, and protect Work which may be damaged by this operation in an accepted manner. Be responsible for fallout and for protecting persons, adjacent work and property. Comply with requirements of the *Building Code* and all agencies having jurisdiction.

D. Deicing Chemicals: In a freezing environment, it is anticipated that Contractor may need to provide or may be required to provide deicing chemicals for use on slab surfaces. The storage and the use of such chemicals is subject to the following requirements:

1. Contractor's attention is drawn to the fact that such chemicals have led to the destructive corrosion of reinforcing steel and to other problems in structures such as this one (including apartments, laboratories, office buildings, schools, and the like).

2. Storage of such chemicals shall be provided with a complete and an effective barrier to the supporting concrete.

3. Where such deicers are placed on slabs, they shall be swept up at the earliest practical moment. Where directed, sweeping shall be followed by a wash-down operation.

4. Deicing chemicals and barrier systems shall be fully compatible with all subsequent finishes and toppings.

5. Formwork, reinforcement, and construction joints shall be protected from all deicing chemicals used on site. Deicing chemicals should never be used to remove ice from reinforcement or formwork.

E. Structural Repairs: Conform to Section 5.3.7 of ACI 301, *Specifications for Structural Concrete*, and to accepted procedures. Use the specified polymer repair mortars and epoxy adhesives. Proposed structural repairs need be submitted and approved prior to performing the repair.

F. Out-of-Form Concrete: Achieve the following finish as required by the Drawings, and by this Specification:

1. It is the intent of this Specification that all painted concrete and all exposed unpainted concrete be cleaned, dressed, and receive a grout clean down. Offsets shall be leveled and ground where necessary. In the event remedial action is required, it shall consist of cutting and patching. Causes for remedial action include rock pockets, honeycomb and spalling.

2. Clean shall mean the removal of all stains, laitance, transferred form oil, curing compound residue, and dirt from the surface in a manner which avoids staining, scarring or scratching the surface. Surfaces to be painted shall be cleaned ready to receive paint. Coordinate with Paint Section of this Specification.

a) Apply cleaning/finishing solution in an even manner, break-to-break or joint-to-joint, on surface; allow to set before flushing with a pressure spray. Accomplish in a consistent manner throughout project.

b) Treatment shall produce a "matte" surface by removing just the surface of the cement-paste skin.

3. Dress shall mean removal of all runs, splatters, fins and projections in a manner which avoids scarring, staining or scratching the surface.

4. Cutting and Patching shall mean the removal of unsound concrete, the wetting of the effected area, the application of a fine aggregate (#30 screen) and cement matrix matching the in-place concrete, to repair surface voids, honeycomb, rock pockets and spalling and the filling of tie holes, and the application and curing of the applied matrix. Patches shall be compacted thoroughly, screeded a little high, and finished flush with float or trowel. Patches shall be kept continuously moist for not less than 7 days.

G. Hole Cutting in Hardened Concrete:

1. It is the intent of these Specifications that hole cutting in hardened concrete will not be required. In the event that hole cutting is required, Contractor shall prepare appropriate details and procedures to accomplish the work and shall submit such details and procedures for acceptance. Cutting holes in the hardened concrete shall conform strictly to accepted details and procedures.

2. Prior to cutting holes, use a pachometer to locate all potentially affected reinforcing bars, conduits and pipes. Perform coring to avoid touching, cutting or damaging existing reinforcement. Cut reinforcement or embedded items only in accord with accepted details and procedures.

3.15 CURING, SEALING,HARDENING, DENSIFYING AND PROTECTION

A. Curing Formed Concrete: Conform to all applicable recommendations of ACI 305, ACI 306, and ACI 308.

1. Protect newly placed concrete against rain wash, low and high temperature effects and against premature loss of moisture.
2. Heating of concrete for curing in cold weather shall be by means and methods which do not cause carbonization effects in the concrete. Erect wind breaks and weather protection when and where required.

B. Wet Curing shall be for at least seven days at a temperature of at least 50°F (10°C) by continuous fog spray, immersion in water-tight covering of polyethylene to retain moisture or other accepted means. Do not use chemical curing on surfaces to be wet cured without specific acceptance.

C. Curing Compounds: Concrete may be cured with the specified curing compound providing the following requirements can by met:

1. All exposed interior slabs, not receiving a liquid densifier, and troweled slabs receiving mastic applied adhesives or “shake-on” hardeners shall be cured with the specified curing and sealing compound. Exterior slabs, sidewalks, curbs, and Architectural Concrete, not receiving a penetrating sealer, shall be cured with the specified clear, non-yellowing curing and sealing compound. Maximum coverage shall be 400 ft^2/gallon on steel troweled surfaces and 300 ft^2/gallon on floated or broomed surfaces for the curing/sealing compound.
2. Strippable Curing Compound: All slabs, where indicated on the drawings or where approved, shall be cured with the specified strippable curing compound applied in strict accordance with the manufacturer’s recommendation.
3. Compounds which diminish bond or adhesion of finish materials, topping slabs, mortars and the like to concrete surfaces shall not be used or shall be totally removed prior to installation of affected Work. Contractor shall coordinate respective subcontractors and shall be solely responsible to determine and to assure compatibility of curing compound with both concrete and with overlying materials.

D. Liquid Densifier/Sealer:

1. Apply liquid densifier/sealer on exposed trowel finish interior floors subject to small hard-wheeled vehicular abrasion and “shake-on” hardener slabs as indicated on the Drawings.
2. Compound shall be mechanically scrubbed into the surface in strict accordance with the directions of the manufacturer and just prior to completion of construction.

3. Compounds which diminish bond or adhesion of finish materials, topping slabs, mortars and the like to concrete surfaces shall not be used or shall be totally removed prior to installation of affected Work. Contractor shall coordinate respective subcontractors and shall be solely responsible to determine and to assure compatibility of curing compound with both concrete and with overlying materials.

E. Polymer Repair Material for Leveling Low Spots shall be mixed, applied, cured and finished in strict accordance with the recommendations and instructions of the manufacturer.

F. Protection: Protect concrete Work from overloading and from defacement of any nature during construction operations.

3.16 FORM REMOVAL AND RESHORING

A. General: Forms and/or shores and reshores shall be removed only after the supported concrete has achieved sufficient strength to allow the structure to support the weight of concrete plus all superimposed live loads and lateral forces including construction live loads to be placed thereon, without damage to the structure, overstress or excessive deflection. Contractor shall perform, at no expense to Owner, all tests and calculations needed to show when forms, formwork supports, shores and reshores can be removed without endangering the structure, subject to the following limitations:

1. Contractor shall be solely responsible for proper removal of forms and maintenance of safe working conditions for personnel.
2. Do not damage arises or exposed concrete surfaces with tools or other devices when removing formwork. Repair or replace, as directed, all Work damaged due to improper or early removal of forms.

B. Vertical Forms may be removed 24 hours after concrete is placed contingent upon concrete having been maintained throughout that period at temperatures in excess of 50°F (10°C), upon achieving concrete strength adequate for stripping, and provisional on the implementation of effective curing procedures.

END OF SECTION 03 30 00

SECTION 05 10 00 - STRUCTURAL STEEL

PART 1 - GENERAL

1.1 CONTRACT DOCUMENTS

A. Comply with Contract Documents: All Work of this Section shall comply with the requirements of the Conditions of the Contract (General, Supplementary, and Special), with all Sections of Division 1 - General Requirements, with this Section of the Specification, with the Drawings and with all other Contract Documents.

B. Flammable Materials or materials not conforming in all respects to the fire resistive and fire safety provisions of governing regulations shall not be left in place in the Work.

C. Disposition of and Exposure to Materials: Contractor remains fully responsible for the disposition of and for the exposure to persons of all materials, whether or not hazardous.

D. Volatile Organic Compounds (VOC): Contractor remains fully responsible for the supplying of products and materials complying to the VOC limitations set forth by the *Building Code* and by governing agencies having jurisdiction.

1.2 WORK INCLUDED

A. Scope: Contractor shall examine all of the Contract Documents for the extent of the Work of this Section of the Specifications. That Work shall include all labor, materials, devices, plants, tools, equipment, appliances and services necessary to complete the Work as shown in the Structural Drawings, as specified herein, as required by job conditions, and as required by governing authorities having jurisdiction, including but not limited to the following:

1. Beams, columns, girders, bracing, all including connections and associated Work.
2. Base plates and bearing plates.
3. Posts, struts and hangers.
4. Surveying but not furnishing or installing items such as anchor bolts, wall and anchor plates, and the like constructed in Package I and necessary for the installation of the work of this specification.
5. Steel support brackets, seat angles, and material for the support of concrete slabs.
6. Angles, plates and the like to support metal deck.
7. Galvanizing, shop and field painting, and field touch-up.
8. Field surveying of as-erected structural steel and re-plumbing as required.
9. Shop applied stud shear connectors.

10. Shop applied concrete anchors.
11. Supplying and installing of lintels, where attached to structural steelwork.
12. Bracing, guying and plumbing of structural steelwork.
13. Protection of Work of this Section.
14. Protection of other Work from activities under this Section.
15. Determination of detail dimensions, member locations and the like from information provided in the Architectural and Structural Drawings and/or as provided by Architect.
16. Connection design by Contractor's Professional Engineer.
17. Review and development of Construction Sequence as proposed by or implied from the Contract Documents.
18. Review of Contractor-prepared Construction Sequence by Contractor's Professional Engineer.
19. Shop Drawings, samples and submittals.
20. Provisions for other Work, including holes through structural steel for other Work.
21. Cooperate with Owner, with Construction Manager, with Architect and with Testing Agency in all aspects of quality assurance and in all other activities related to the Work of this Section.
22. The safe handling and disposition of materials related to the Work of this Section, whether or not hazardous.
23. All other labor, materials and Work given in the Drawings, specified herein or required to make the structural steel Work complete.

B. Work Installed as Specified Elsewhere: Contractor shall examine all of the Contract Documents for the extent of Work to be installed under this Section.

1.3 RELATED WORK

A. Related Work Specified Elsewhere, Amplified Elsewhere or Included in Other Contracts:

1. Submittals: Section 01 30 00.
2. Owner's shop and field testing and inspection of Work by Testing Agency engaged and paid for by Owner: Section 01 40 00.
3. **Installing anchor bolts and embedded plates in concrete: Section 03 30 00.**
4. Non-shrink grouting for structural steel base plates:Section 03 30 00.
5. Cast-In-Place Concrete: Section 03 30 00.
6. Masonry: Division 4.
7. Metal Deck and Field-Applied Stud Shear Connectors: Section 05 30 00.
8. Miscellaneous Metals: Section 05 50 00.
9. Sprayed Fireproofing: Section 07 25 00.
10. Finish Painting of Exposed Structural Steel: Section 09 90 00.

1.4 APPLICABLE CODES AND STANDARDS

A. General: Except as modified or voided by requirements specified herein or by details or notes included in the Drawings, Work specified under this Section shall conform to all applicable provisions of the codes, specifications, standards and other reference documents cited in this Specification and/or noted in the Drawings. In the event of conflict between provisions of stipulated reference documents and of this Specification or of another stipulated reference document, Contractor shall report in writing the details of the conflict. Decisions regarding applicability of provisions of this Specification and provisions of reference documents applied independently or as supplemented, modified or voided, will be provided in writing and shall be final. Resolution of conflicts shall conform to the procedures set forth in the General Conditions of the Contract.

B. Codes: All Work under this Section shall conform to the requirements of the 2022 Connecticut State Building Code, hereinafter referred to as *Building Code*, and to the regulations of all governmental authorities having jurisdiction. Where more stringent, the following codes, standards and specifications, latest edition and revision, shall apply to the Work, all as modified herein or by *Building Code*:

1. *Specification for Structural Steel Buildings, AISC 360,* by the American Institute of Steel Construction (*AISC*).
2. *Code of Standard Practice for Steel Buildings and Bridges*, published by the American Institute of Steel Construction (*AISC Code*). Sections 6, 7, 8 and 10, only, shall apply to the Work, except as modified in this Specification; the remainder being specifically excluded.
3. *Structural Welding Code - Steel*, AWS D1.1.
4. *Structural Welding Code - Sheet Steel*, AWS D1.3.
5. *Specification for Structural Joints Using* ASTM A325 *or A490 Bolts*, approved by the Research Council on Structural Connections of the Engineering Foundation (RCSC Specification). Endorsed by the American Institute of Steel Construction, and the Industrial Fasteners Institute.
6. *Standard Symbols for Welding, Brazing, and Nondestructive Examination*, AAWS A2.4.
7. *Structural Welding Code - Reinforcing Steel*, AAWS D1.4.
8. *Specification for Design of Cold-Formed Steel Structural Members*, by the American Iron and Steel Institute.

C. Reference Documents: To the extent that the best quality of Work is provided, Work shall conform to the examples, procedures and recommendations listed below, latest edition and revision. Where provisions of the *Building Code,* this Specification, or codes, standards, manuals and specifications cited by this Specification are more restrictive or provide increased quality, the combination of provisions, examples, procedures and recommendations which provide both best quality and *Building Code* conformance shall control the Work.

1. *Steel Construction Manual* by American Institute of Steel Construction (*AISC Manual*). Contractor shall keep at least one full copy in the field office at all times.
2. *Detailing for Steel Construction*, by the American Institute of Steel Construction.
3. SSPC *Steel Structures Painting Manual*, *Volume 1, and Volume 2*, by Steel Structures Painting Council.
4. *Guide for the Visual Inspection of Welds, ANSI/AWS B1.11.*
5. *Qualification of Post-Installed Mechanical Anchors in Concrete*, ACI 355.2.
6. *Qualification of Post-Installed Adhesive Anchors in Concrete*, ACI 355.4

D. ASTM (American Society for Testing and Materials) Specifications cited in this Specification or cited in reference documents shall be the year of adoption or tentative adoption and revision listed in the latest edition of the Annual Book of ASTM Standards*, Index*, except that, should a specific year of adoption or revision be cited by the Contract Documents, by *Building Code*, or be proposed by Contractor and accepted by Structural Engineer, that edition shall apply to and shall control the Work.

E. Conformance to Regulations: Work of this Section shall conform to all applicable federal, state, and local laws and regulations.

1.5 SUBMITTALS

A. General: Submit samples, Shop Drawings, product data, test reports and data, manufacturer's names, certifications, procedures, methodology statements, and the like as stipulated. With the exception of samples, submittals shall be in PDF format and transmitted electronically, unless otherwise accepted.

1. Review of Contractor's submittals is only for the limited purpose of the examination of submittals for conformance with the design concept of the project and to assist Contractor in ascertaining that the information given in the submittals conforms to the requirements of the Contract Documents.
2. Review of Contractor's submittals is not conducted for the purpose of determining the accuracy or the completeness of the submittal, for dimensions or quantities, or for installation or performance of the system or the piece(s) being submitted.
3. Submittals by Contractor implies that Contractor has checked the submittal with care. Where by error or other cause, Contractor's check has not been accomplished, Contractor shall not rely on review but shall first check and shall then resubmit such material as though the submittal had been rejected.

B. Samples: Submit for acceptance prior to purchase, fabrication or delivery:

1. Post-installed anchors; each type.
2. Substitute Products, Materials and Fixtures, where requested by Contractor, shall be accompanied by sample(s) of an acceptable size.
3. Other Products, Materials and Fixtures, where requested in writing.

C. Shop Drawings:

1. General: Shop Drawings, as the term is used under this Section, are not Contract Documents, but are intended to demonstrate the way that Contractor intends to conform to the requirements provided in the Contract Documents. Contractor may wish to use these same drawings as a part of the instructions given to craftpersons for the accomplishment of the Work.

2. Best Standards: Shop Drawings furnished under this Section shall conform to the best standards of the construction industry and shall be not less complete than indicated by the applicable procedures shown in AISC's *Detailing for Steel Construction*. Shop Drawings shall be prepared by and under the supervision of competent engineering personnel. Prior to preparation, Contractor shall retain a Professional Engineer, accepted by Construction Manager and by Structural Engineer and registered in the State of this project, to supervise the preparation of and to check each Shop Drawing for compliance with the requirements of the Contract Documents.

a) Shop Drawings shall be prepared under the direction of personnel completely familiar with Architectural, Mechanical, Plumbing, Electrical and other building trades Drawings

b) Contractor shall provide detailer with tool clearances needed for both shop and field bolted connections.

3. Shop Drawings shall be submitted for review and to governing agencies having jurisdiction for acceptance in accordance with the provisions of the Contract Documents.

4. Shop Drawings shall be submitted in parts as follows:

a) Job Standards
b) Erection Drawings
c) Index Sheets
d) Piece Drawings
e) Field Work Drawings

5. Job Standards are intended to assist Contractor by developing the set of repetitive details, whether shop or field, welded or bolted. Job Standards shall be accepted prior to the commencing of dependent Work for Piece Drawings. Provide supporting calculations on request. The "name" or designation of the appropriate Job Standard connection shall be given in the Erection Drawings for each piece carrying a Job Standard connection. Job Standards are a vital and an essential part of the overall Shop Drawing submittal.

6. Erection Drawings shall show clearly the size, grade and location of each member. To the extent desired by Contractor, the Structural Drawings may be used for this purpose. In addition to basic information given in the Structural Drawings, Erection Drawings shall contain (for each piece) the erection mark, the job standard connection mark, beam copes and blocks as given in the next page of this Specification, the location, size and reinforcing of beam penetrations, the elevation of top of beam, (where sloped) the elevation of the work point of both ends, camber, and such projecting elements as may be of concern to Architect.

Additionally:

a) Show each field connection complete with data and details necessary for assembling the structure. Direct special attention to the possible need for special guying, bracing or shoring to prevent deformation of existing or new structure due to stresses caused by erection procedures and equipment, by construction loadings and by forces imposed by natural phenomena.

b) Prepare post-installed anchor and base plate Erection Drawings containing complete location and placing details. Include details of erection templates. Provide Erection Drawings to the concrete trade in advance of applicable Work and in coordination with concrete construction sequence.

c) Contractor's Professional Engineer licensed in the project's jurisdiction shall review and accept Contractor's construction sequence. As evidence of conformance with this requirement, Contractor shall submit a letter bearing the seal and signature of Contractor's Professional Engineer, attesting to conformance with this requirement.

7. Drawing Index: Prepare, keep up-to-date, and submit a Drawing Index, cross-referencing assigned piece mark with the drawing number upon which the piece is detailed. Erection Drawings may be used for this purpose. Shop Drawings submitted without an up-to-date Index and the applicable Erection Drawing(s) showing the location of each piece, will be deemed an incomplete submission and will not be accepted as subject to any agreed Shop Drawing schedule.

8. Piece Drawings will not be reviewed for the information identified below that is to be contained within the Job Standards and Erection Drawings. Piece Drawings with given pieces having potential impact on building systems not associated with the Work of this Section will be reviewed.

9. Submit Job Standards, Erection Drawings, Drawing Index and Piece Drawings in coordinated packages so that checking personnel will have all needed information in hand at the time of checking.

10. Field Work Drawings: Prepare Field Work Drawings depicting all field Work required to accommodate field conditions.

11. Shop Drawings shall include plans, elevations, sections and complete details to describe clearly, at an ample scale, all Work to be provided. Shop Drawings shall be accurately dimensioned and shall be notated clearly.

12. Size and Grade of Steel for each component part of the structure shall be indicated clearly in Shop Drawings. Rolled shapes, tubes, plates and other components shall be identified by using the standard designations used in AISC's *Detailing for Steel Construction*.

13. Symbols: Welds and nondestructive tests shall be indicated by using the symbols conforming to AWS A2.4, *Standard Symbols for Welding, Brazing, and Nondestructive Examination*. Indicate joint designation, welding process, and other data in the tail of the welding symbol.

14. Detail in accord with and to accommodate Contractor's field measurements of supporting and adjoining construction. Do not fabricate before accepted Shop Drawings have been returned to Contractor.

15. Work of Other Sections: Show in Shop Drawings holes and other Work required for securing Work of other Sections to structural steelwork, as well as holes and other Work required for the passage of Work of other Sections through structural steelwork. Pay particular attention to the requirements of the Work specified under Section 03 30 00. Provide Field Work drawings for all such holes not shown in Shop Drawings.

16. Structural Steel Connections: Identify explicitly the type of connection used at each location. Distinguish between shop and field connections. Determine and establish the arrangement and layout of each connection to the extent that detailing options are allowed in the Drawings or in this Specification. Connections shall be proportioned by LRFD, or by ASD where allowed specifically in the Drawings and shall conform to controlling requirements given in the Drawings, specified herein, or required by the *Building Code*.

a) Proportion connections not completely detailed in the Drawings to resist loads and load combinations given, noted, specified or required by the Contract Documents or by *Building Code*. Include reinforcing plates, web doubler plates, stiffeners and all else required to provide adequately for the given loads and load combinations.

b) As a part of the preparation of Shop Drawings, Contractor's Professional Engineer licensed in the project's jurisdiction shall design and be responsible for the design adequacy of all connections required by the Work, unless detailed completely in the Drawings. Contractor shall submit a letter bearing the seal and signature of Contractor's Professional Engineer, attesting to conformance with this requirement. Provide supporting calculations on request.

c) Contractor shall ascertain that all connections have sufficient strength, stiffness and ductility to resist safely loads imposed by handling, shipping, erection, temporary conditions and the like.

d) Except where smaller connections are given explicitly in the Contract Documents, and except where larger connections are required to resist loads from handling, shipping erection and the like, Contractor shall provide connections for members in trusses and bracing capable of resisting not less than 50% of the tensile strength of the members.

e) Fillet welds, partial penetration welds, weld returns, plug welds and the like shall equal or exceed the sizes given in the tables and notes included in the Drawings and in all cases shall equal or exceed the minimums permitted by *AISC Specification*.

f) Single-angle, one-sided and other types of eccentric connections shall not be used except where more concentric connections are not practical. Use of such eccentric connections is subject to prior acceptance.

g) Prior to start of Shop Drawings, Contractor shall select and shall submit for acceptance the range of bolt sizes to be used for each grade of bolt. There shall be no overlap in bolt size between grades.

17. Indicate clearly the grade, size and number of bolts, the type, number, position, designation and orientation of each washer, the bolt tension indicating system and the size of each hole, whether slotted or round. Proportion connection details to ensure adequate wrench clearance for correct bolt tensioning sequences.

18. ASTM A490 bolts may be used in slip critical-type connections only, not relying on the bearing capacity of the connection and not to carry direct tensile loads.

19. Camber and Sweep: Show all camber dimensions in Shop Drawings. Where specific camber is not given in the Drawings, note in affected Shop Drawing that such members shall be fabricated with natural camber up. Detail, fabricate and erect beams and girders so that natural sweep is away from the immediately adjacent edge of slab.

20. Deck Supports: Indicate specifically in Shop Drawings all structural steel shelves required to support steel deck ends and edges at supporting beams, columns, and other structural steel elements. Detail steel deck shelves to provide suitable dimension and configuration to develop steel deck end and edge welding and reactions.

21. Lintels and other secondary members requiring erection tolerances closer than those permitted herein shall be provided with appropriate slotted holes and shall be connected with ASTM A325 SC bolts. Increase member size where required to provide adequate space, edge and end distances for slots.

22. Cleaning, Surface Preparation (SSPC), and Painting data and requirements, including specific identification of "no-paint" areas, shall be detailed and scheduled in Shop Drawings.

23. Contractor shall coordinate and cross-check for accuracy, completeness and correct relationship to the Work of other Sections, each Shop Drawing prepared for the Work of this Section, including each Shop Drawing prepared by accepted subcontractors. Contractor's check shall include a verification of compliance with the Contract Documents and shall be performed prior to submission and resubmission of each Shop Drawing. The personally inscribed initials of the person(s) preparing each Shop Drawing as well as the detailing agency's supervisor and chief checker shall be included in the title block or similarly prominent location.

24. Substitutions: Should Contractor desire a Substitution or Deviation from Drawings or Specifications, or both, Contractor shall submit the specific request in writing prior to the submittal of Shop Drawings showing the Substitutions or Deviations. Requests for Substitutions or Deviations shall be submitted on Contractor's letterhead. Substitutions and Deviations not identified, or identified only in letters of transmittal or in Shop Drawings, or both, without the required written description on Contractor's letterhead, may not be accepted and shall be sufficient cause for the rejection and the return of such Shop Drawings without further action.

a) Acceptance of Shop Drawings including Substitutions and Deviations not detected during Shop Drawing review, shall not relieve Contractor from responsibility to conform strictly to the Contract Documents. Substitutions and deviations will be allowed only where permitted in writing.

b) Substitute structural shapes will be accepted provided both structural stiffness and structure strength are not impaired in both the composite and the non-composite conditions and provided the substitute shape does not interfere with or otherwise compromise the Work of other trades.

c) Architect is the sole judge of the suitability of Contractor-proposed substitutions. Review of Contractor-proposed substitutions and deviations is subject to the compensation provisions of Article 1.12.

25. Shop Drawing Review: Only Shop Drawings marked "No Exceptions Taken" or "Make Corrections Noted - Resubmission Not Required" may be used by Contractor in the Work. Shop Drawings marked "Make Corrections Noted - Resubmit" shall be corrected or completed (or both) as required and shall be resubmitted. This process shall be repeated the number of times required to achieve the mark "No Exceptions Taken" or "Make Corrections Noted" - "Resubmission Not Required". An example of Structural Engineer's Shop Drawing review stamp is shown here for reference.

STRUCTURAL ENGINEER REVIEW

NO EXCEPTIONS TAKEN ☐ RESUBMISSION NOT REQUIRED ☐
MAKE CORRECTIONS NOTED ☐ RESUBMIT ☐
NOT REVIEWED ☐

LESLIE E. ROBERTSON ASSOCIATES

BY: _____

DATE: _____

a) Review of Shop Drawings will include the following:
   i) Member size, grade, spacing and elevation.
   ii) Structural integrity of connections, including conformance to job standard.
   iii) Penetrations, including size, location and conformance to job standards.
b) Temporary, shipping, handling or erection loadings will not be considered in this review.
c) Nonconformities and errors detected during review will be noted in Shop Drawings returned to Contractor upon completion of review. Acceptance of Shop Drawings, including Substitutions and Deviations not detected during review, will not relieve Contractor from sole responsibility to provide Work conforming strictly to the Contract Documents.
d) Shop Drawing review includes engineering calculations only to the extent deemed necessary to ascertain that Contractor's Shop Drawings have been prepared by competent personnel. Contractor alone is responsible for the accuracy and the completeness of Contractor's engineering calculations.
e) Should Architect's or Structural Engineer's marks or corrections be made in any Shop Drawing that would or could result in incorrect fit of any part or result in insufficient strength or stability of the Work, Contractor shall so notify in writing so as to expedite the required correction or modification.

f) Review of Contractor's Shop Drawings does not include a review of bills of material and the like. Accordingly, information required for the review of Shop Drawings shall be contained outside of bills of materials and the like.

26. Resubmission of Shop Drawings: Prior to resubmission of Shop Drawings with additions, deletions, or corrections, Contractor shall cloud and identify all changes from the prior issue. Drawings submitted without each change both clouded and identified clearly will be returned and shall be resubmitted as though the original submittal had been rejected. Each submittal, whether or not accepted or rejected, shall contain a unique revision number, clearly identified.

27. Temporary Work: Depict and identify temporary members and connections which may be required for temporary construction, erection and the like.

28. Shop Drawing Log: Contractor shall number Shop Drawings, and revisions to Shop Drawings, in a format acceptable both to Contractor and to Architect/Structural Engineer.

D. Product Data: Submit printed manufacturer's literature for each manufactured item specified under Part 2 - Products - along with test data as may be requested. Include detailed instructions for application and installation.

E. Mill Test Reports:

1. Submit certified copies of mill test reports for all steel furnished. Submit also to governing agencies having jurisdiction. Comply with all applicable parts of ASTM Specifications. Beyond ordering information normally provided by Contractor, the mill shall be instructed to color-code in accordance with ASTM A6, and to mark with heat number, size, and type and grade of steel.

2. Submit manufacturer's certification of bolts, nuts, washers, DTI's and the like for each production lot of each grade of each type and each size of fastener component and filler material for welding.

3. Mill test reports shall state clearly the governing ASTM specification and shall be certified and notarized by Contractor as conforming in all respects to that specification.

4. Material provided in accord with the above requirements may be used in the Work without further local tests. In the case of controversy, Contractor shall perform tension, bend and such other tests as are required to demonstrate compliance with the requirements of the Contract Documents.

5. All steel that is not properly identified or whose source is subject to question shall be rejected.

6. Steel pipe and tubing shall have not less than one tension, one bend, and one flattening test for each one hundred lengths or fraction thereof, for each size, for each wall thickness and for each grade. Both tension and bend tests shall be made from coupons taken longitudinally.

F. Material Identification: On completion of the Work, Contractor shall submit an affidavit, countersigned by the appropriate subcontractor(s), attesting that all materials and products provided for the Work conform to the applicable specifications, standards, yield points, grades and the like required by the Contract Documents.

G. Certification of Shielding Gas: Submit certification that shielding gas is a weldable grade having a dew point of -40°F (-40°C) or lower.

H. Names of Manufacturers/Suppliers: Submit for acceptance the names of the following products and/or producers along with certification that the products conform in all respects to the requirements of the Contract Documents:

1. plates and shapes
2. welding materials
3. shielding gas
6. bolts, nuts and washers
7. bolt tension indicating devices
8. post-installed anchors
9. anchor bolts
10. shop and field paint and galvanizing
11. gratings

I. Post-Installed Anchor Certificates: Submit approved independent testing report per ACI 355 (ICC-ES report), Manufacturer's Printed Installation Instructions, letter describing installation procedures, and installer qualifications including certification for horizontal and overhead adhesive installation where applicable.

J. As-Built Shop Drawings: In a format acceptable to each, and at the completion of the Work, provide to Owner, to Architect and to Structural Engineer, one complete digital set of all Shop Drawings (including Job Standards, Erection Drawings, Index Sheets, Piece Drawings, Field Work Drawings and the like), so as to provide as-built drawings of finished and completed Work under this Section.

K. Governing Agencies: Provide all Shop Drawings, tests, inspections, reports, affidavits, manufacturer's certifications, certification of compliance with VOC limits, and other requirements and data to governing agencies having jurisdiction.

1.6 MEASUREMENTS, TEMPLATES AND TOLERANCES

A. Measurements:

1. Field Measurements: Obtain all field measurements required for proper fabrication and installation of Work covered by this Section. Submit, prior to installation, all measurements indicating discrepancies from the Drawings. Describe in writing and, where applicable, by sketches proposed methods of correcting discrepancies. Measurements are the responsibility of Contractor.
2. Lay out each part of the Work in strict accordance with the Architectural, Structural, Mechanical, Electrical, Plumbing and all other Drawings and be responsible for correct location of same. Lay out from at least two pre-established benchmarks and axis lines, individually correct for length and bearing.

3. Templates: Furnish templates and layout drawings for exact locations of items to be embedded in concrete, with setting instructions required for installation of embedded items.

4. Field Survey: Provide all field survey measurements required by Construction Manager for coordination with Curtain Wall and other trades installation.

B. Tolerances: Structural steel shall be fabricated and erected within the tolerances specified in the *AISC Specification*, *AISC Code*, and AWS, except that more or less restrictive tolerances, specifically shown or noted in the Drawings or provided under this Specification, shall take precedence and shall apply to the Work.

1. The plumbness tolerance of columns, sometimes given as 1:500, shall be taken as the square root of the sum of the squares of the slope for the two orthogonal axis.

2. Individual floor beams and girders shall be considered level where the difference in elevation between ends of the members does not exceed 1:750. Spandrel beams and girders shall be considered level where the difference does not exceed 1:1500.

3. Overall plan dimensions shall not vary by more than plus or minus 1:2000 for the overall length or width or two diagonally opposite extremes, all measured to the centerline of columns.

4. Columns along the perimeter column lines shall fall within 1/2 inches (12 mm) of the best fit straight line describing the column line.

1.7 TESTING AND INSPECTION

A. Owner's Testing Agency: All work is subject to Special Inspection as required by *Building Code*. Subject to acceptance by Architect, Owner will engage and pay for the services of an independent testing agency (Testing Agency) as outlined in Section 01 40 00, Inspection and Testing. The selected Testing Agency will meet the requirements of ASTM E329. Contractor alone is responsible for the achieving of the required level of quality, both in the shop and in the field. Testing Agency will rely heavily on reviewed Shop Drawings, as described earlier in this Specification, in its examination of as-constructed Work. Contractor shall not retain Owner's Testing Agency for its own work but may, subject to acceptance by Owner, contract through Owner for such Work.

B. Responsibilities and Duties of Testing Agency: Testing Agency will perform the following functions, inspections and tests:

1. On instructions and at locations selected by Architect, Testing Agency may sample materials taken from the as-erected Work.

a) High-tensile bolts, nuts and washers, of each size and grade, may be sampled and tested in accord with ASTM procedures.

b) Coupons may be taken from structural steel shapes and plates and welds and tested in accord with ASTM procedures

2. Inspectors provided by Testing Agency will be qualified to examine the materials and the systems employed in the Work. In case of dispute between Contractor and Testing Agency as to the competence of any inspector, Structural Engineer shall be the final arbiter.

3. Both tests and inspections will comply with the requirements of the *Building Code*, as amended by the requirements and regulations of the Building Department and as Specified herein.

4. Testing Agency will inspect all shop and field welding, and high-strength bolting in accord with the provisions of this Specification. Testing Agency, upon the completion of the Work, will be required to certify in writing that the welding and the high-strength bolting has been performed in accordance with the provisions of the Drawings and with this Specification, and with the applicable requirements of regulatory agencies having jurisdiction.

5. Testing and reporting by Testing Agency will be performed in accord with the following requirements:
   a) Testing will be performed in accord with the provisions of ASTM A370, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*.
   b) Liquid penetrant testing will conform to the provisions of ASTM E165 and AWS D1.1.
   c) Magnetic particle inspection will conform to the provisions of ASTM E109 and AWS D1.1.
   d) Ultrasonic, X-ray and gamma ray testing will conform to the provisions of AWS D1.1, Chapter 6.

6. Test specimens shall be taken by Contractor under the direction of Testing Agency and shall be machined by Contractor to dimensions required by the related ASTM specification and/or AWS standard.

7. Continuous inspection of high-tensile bolting will be performed by Testing Agency. Where the tension in any bolt is deemed to fall below the proper value, all bolts in that connection shall be examined.
   a) All bolts will be visually examined for proper tension.
   b) Ten percent of the bolts, but no fewer than two bolts, selected at random from each connection in question, shall be tested for bolt tension in accord with the provisions of the *Specification for Structural Joints Using ASTM A325 or A490 Bolts*.

8. Inspection of all shop and field welding will be provided by Testing Agency.
   a) All welds are to be visually inspected.
   b) Ten percent of the bolts, but no fewer than two bolts, selected at random from each connection in question, shall be tested for bolt tension in accord with the provisions of the Specification for Structural Joints Using A325 or A490 Bolts.

9. Continuous inspection of complete penetration welds will be provided by Testing Agency using ultrasonic or other non-destructive tests.
   a) Ultrasonic tests will be performed by specifically trained, qualified technicians, who will operate the equipment, visually examine the welds and will maintain records of welds examined, defects found and disposition of each defect. Technician will sign each weld that he or she inspects.
   b) Inspection instrumentation will be calibrated by the Testing Agency in accord with AWS D1.1.

c) Welds requiring ultrasonic testing will be tested at an initial rate of 100% in order to authenticate the qualifications of each welder and each welding operator. Where the rejection rate is found to be less than 5% of the welds tested, the frequency of testing may be reduced to 25%. Where the rate of rejection increases to 5% or above, the inspection rate will again be increased to 100% until the defect rate is reduced to less than 5%. Percentages will be calculated for each welder separately.

10. Where ultrasonic indications arising from the weld root can be interpreted as either a weld defect or a back-up bar, the bar shall be removed by Contractor and back-welded, where required. The weld will then be retested. Questionable root indications, where no defect is found, will not be counted against the welder's rejection rate.

11. All material stressed transverse to the grain by welds, located within 6 inches (150 mm) to either side of the weld, will be tested ultrasonically for laminations. Testing will be in accord with ASTM A578.

12. Approximately 25% of groove welds accomplished in the shop will be retested in the field. Retesting will not take place until the welds are not less than 4 days old. Similarly, approximately 25% of material stressed transverse to the grain will be retested for laminar tearing.

13. Perform Special Inspection of post-installed anchors in accordance with the Building Code, Manufacturer's Printed Installation Instructions, approved independent testing report per ACI 355, Contract Documents and approved shop drawings. As a minimum, provide continuous inspection of adhesive anchors installed in horizontal, or upwardly inclined orientations, supporting tension loads; and periodic inspection of all other conditions of post-installed anchors. Special Inspectors shall be qualified (via experience, training, ACI/CRSI certification, etc.) with the installation and inspection of post-installed anchors. Special Inspections shall include but are not limited to the following:

a) Verify installer qualifications as required per the Contract Documents;
b) Verify anchor type, material, size, length, and condition;
c) Verify minimum concrete age, temperature, strength, and dry condition;
d) Verify drilling method, hole cleaning, preparation per Manufacturer's Printed Installation Instructions; and
e) Verify anchor position, setting, and installation method

C. Authorizations: Owner's Testing Agency will not be authorized to:

1. Authorize or accept deviations or substitutions from the Contract Documents.

2. Assume any of the responsibilities of Contractor; for example, Testing Agency may not advise formally or informally on any aspect of construction means, methods, techniques, sequences or procedures, or safety precautions and programs in connection with the Work.

3. Accept Shop Drawings or samples.

4. Approve or issue a Certificate of Payment, a Change Order, or issue verbal instructions which modify the Contract between Owner and Contractor.

D. Responsibilities and Duties of Contractor:

1. Performance or waiving of inspection, testing or surveillance by Testing Agency for a given portion of the Work will not relieve Contractor from responsibility to conform strictly to the requirements of the Contract Documents.

2. Access to Documents, Facilities and Materials: Furnish one copy of each accepted Shop Drawing and of each mill test certificate to Testing Agency. Provide reasonable office, desk and file space at each fabrication plant and at the site to allow Testing Agency to conveniently work with and to maintain project records and drawings. Provide authorized personnel convenient and free access to all parts, locations and areas of Work, including storage areas. Provide representative samples, coupons and the like as requested by Testing Agency. Provide hoisting, turning and moving of materials and reasonable quantities of scaffolding, power, casual labor, and other provisions and assistance necessary to allow quality and effective inspection and testing of Work.

3. Notice: Provide reasonable notice of the initiation of Work, including fabrication or erection requiring plant or jobsite testing or inspection.

4. Cost of Owner's Tests by Testing Agency will be borne by Owner. However, where additional tests are deemed necessary on account of failure to pass tests, the cost of additional testing will be deducted from payments to Contractor so as to reduce the Contract price.

E. One Shop Location is Assumed for purposes of this Contract. Where fabrication takes place in more than one shop, additional inspection costs resulting therefrom will be accomplished at Contractor's expense.

1.8 QUALITY ASSURANCE

A. Source Quality Control: Contractor's material control procedures shall be effective and shall assure that all Work fulfills the requirements of the project as well as the applicable provisions of the Contract Documents. All structural steel shall be identified and all material shall be tested in accord with the requirements of *Building Code*, of Building Department, of governmental authorities having jurisdiction and of this Specification.

B. Shop and Construction Site Quality Control: Contractor shall maintain, on staff, sufficient office, field engineering, and field supervision staff to assure that all data and layout drawings for Work of other Sections is transmitted to detailers to allow proper detailing of holes, penetrations, chases, and the like and to assure proper execution of the Work in the field.

1. Contractor's inspectors shall mark each weld or bolt inspected with an identifying mark. Such inspectors who provide inspections of poor quality shall be assigned to other projects or shall be retrained prior to reassignment to the Work.

C. Steel Fabricator: Fabricator shall have experience in the fabrication of structural steel for at least five (5) buildings of the type of this Work, and shall, within the last five (5) consecutive years, have successfully completed in a timely fashion at least two (2) projects similar in scope and type to the required work of this Section, and shall possess all capabilities and qualifications required for AISC Cbd (Complex Steel Buildings) Certification.

D. Steel Erector: The Erector performing the Work of this Section must, within the last five (5) consecutive years, have successfully completed in a timely fashion at least three (3) projects similar in scope and type to the required work for this Section.

E. Structural Steel Detailer: Should Contractor or the structural steel subcontractor elect to subcontract any portion of the steel detailing Work, the structural steel detailing firm shall be subject to acceptance. As a minimum requirement for acceptance, the structural detailing firm shall demonstrate experience in detailing of not less than five (5) buildings of the type of this work and shall demonstrate in-house quality control procedures to the satisfaction of Construction Manager and of Architect.

1. Acceptance of subcontract detailing firm is provisional and may be withdrawn where detailing is not of sufficient quality to meet project requirements.

F. Bolt Installation shall be in accord with the provisions of this Specification and in no case less than the best industry practice.

1. A qualified representative of the manufacturer shall be present for the start-up installation of each bolt type (DTI and/or TCF) used in the Work. For DTI's, a representative of the bolt manufacturer and a representative of the DTI manufacturer shall be present.

2. Contractor shall provide and shall maintain in good condition a Skidmore Wilhelm bolt tension calibrator (or other device accepted by Structural Engineer) at each location where high-strength bolts are being tensioned. Contractor shall test regularly:

a) each lot of structural fasteners (bolt, nut, DTI, washer and lubricant assemblies) before installation in the Work for the achievement of proper tension; and

b) the competence and understanding of bolting crews for each method of tensioning bolts for each size and grade employed in the work.

3. All members of bolting crews shall be fully instructed and experienced in the bolt tensioning system(s) employed in the Work.

a) Each bolter, both shop and field, shall sign his own name immediately adjacent to each bolt group tensioned by that bolter. Such bolters who fail to follow proper procedures for snugging steel plies or fail to provide proper tension in bolts shall be retrained prior to reassignment to the Work or shall be removed from the Work.

G. Welding Procedure Qualification: Each welding procedure shall be described fully in a welding procedure specification and shall be designated prequalified under AWS D1.1 or shall be qualified in accord with provisions of AWS D1.1 and of *Building Code* prior to use in the Work.

H. Welder Qualification: Welders and welding operators performing work under this Section shall be qualified in accordance with *Building Code* and with applicable AWS requirements for each specific welding procedure and process which the welder will use in the Work.

1. Contractor shall, when requested, require any welder to be retested; retesting, when requested, shall be performed with no additional compensation to Contractor.

2. Welder, both shop and field, shall sign his own name immediately adjacent to each weld accomplished by that welder. Such welders who provide welds of poor quality shall be removed from the Work and shall be assigned to other projects or shall be retrained prior to reassignment to the Work.

a) In addition to normal quality assurance testing by Contractor, all welds not signed shall be tested by Contractor by UT, MT or other appropriate method accepted by Structural Engineer.

I. Qualifications: Contractor shall determine, shall warrant and shall certify that producer, detailer, fabricator, erector, materials suppliers and all others involved in the Work, along with their personnel, are experienced, qualified and adequately staffed to undertake the specific Work required under this Section.

J. Post-Installed Anchors shall be installed by workers with experience and training with installing the specified anchors. Installation of adhesive anchors in horizontal or upwardly inclined orientations supporting tension load shall be performed by installers certified through the ACI/CRSI adhesive anchor installer certification program, or approved equivalent.

K. Documentation of Contract Conformance: Perform quality control functions required to achieve and to document that Work conforms to the Contract Documents. Provide access to Contractor's quality control documents and reports upon request. Provide reasonable numbers of copies of specific quality control reports on request.

1. Contractor shall monitor initial fabrication and from time-to-time during the fabrication period, and shall inspect each delivery prior to loading for shipment. Contractor's monitoring and inspection shall assess the quality of fabricated material by visual inspections, checking of all material test reports, checking of all welding, bolting and other fabrication test reports and the evaluation of quality control procedures through which the fabricated material has passed.

L. Purchase Orders: Each purchase order shall identify the end use of the purchased material. Contractor shall ensure that manufacturer or vendor understands fully the intended use of the material in the Work. Provide manufacturers and vendors with a copy of this Section of the Project Specifications.

1.9 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery of Materials to be Installed Under Other Sections:

1. Anchor bolts, embedded plates, anchorage devices, and other items required to be embedded in cast-in-place concrete shall be delivered to the project site at times coordinated by Contractor to allow convenient installation and orderly cast-in-place concrete operations.

2. Include setting drawings, templates, and directions for installation with all anchor bolts and with all other items or devices furnished and delivered to the project site for installation under other Sections of this Specification.

B. Storage of Materials:

1. Structural steel members and materials, whether or not fabricated, which are stored on or off the project site shall be supported above ground on platforms, skids or other supports. Where applicable, stacked members shall be separated by effective softeners. Storage methods shall protect steel members from overstress, permanent deformation and other damage.

2. Structural steel members and parts shall be protected from corrosion. Storage methods shall provide for free and rapid drainage of rainwater and shall prevent collection of water on or within stored members.

3. Materials shall be delivered to the site, ready for use, in the manufacturer's original and unopened containers and packaging, bearing labels as to type of material, brand name, and manufacturer's name.

4. Packaged materials shall be stored under cover in dry, weathertight, adequately ventilated and clean locations off the ground. Delivered materials which are damaged or otherwise not suitable for installation, shall be removed from the jobsite and replaced with accepted materials.

5. All fastener components shall be protected from dirt and moisture in closed containers at the site of installation. Only as many fastener components as are anticipated to be installed during the work shift shall be taken from *protected storage.* Fasteners components that are not incorporated into the Work shall be returned to *protected storage.* Fastener components shall not be cleaned or modified from the as-delivered condition. Post-installed anchors shall be stored in accordance with manufacturer’s requirements.

C. Identification: Provide and maintain identification of all steels furnished to a specified minimum yield strength greater than 36 ksi (Grade 235) in accordance with *ASTM A6*.

D. Painted Steel:

1. Handling, Shipping and Erecting of shop painted steel pieces shall not be performed until the paint has dried thoroughly. Special care shall be taken to avoid abrasion or other damage to painted surfaces. Stacking and storing of painted members in the shop, in transit, and at the jobsite shall be done using appropriate softeners and timbers suitable to protect the paint from damage and to keep individual members free from contact with the ground and with each other.

2. Contractor shall furnish members in-place, fully painted, including all touch-up painting required as specified herein, at all locations where painting is required in the Drawings, by the provisions of this Specification, and by *Building Code*.

E. Cleaning: Subsequent to shipment and prior to erecting into the Work, Contractor shall clean steel to the extent required to allow full bond of paint or of fireproofing materials, as appropriate.

F. Delivered Materials shall be identical to accepted samples.

G. Removal: Delivered materials which are damaged or otherwise not suitable for installation, shall be removed from the jobsite and replaced with acceptable materials.

1.10 JOB CONDITIONS

A. Contractor's Responsibility: Contractor shall be solely responsible for the correctness of dimensions and quantities and for the fitting to other Work; for Work to be confirmed and correlated at the site; for information pertaining to the fabrication procedure or to the means, methods, techniques, sequences and procedures of construction; and for the coordination of the Work of this Section with the Work of all other trades. The verification of the physical interrelationships of elements of the Work from Contract Documents and in the field is solely Contractor's responsibility. Review of Contractor's submissions does not relieve Contractor from these responsibilities.

B. Contractor's Coordination: Contractor shall coordinate and schedule the Work of this Section with the Work of other Sections of this Specification in order to optimize quality and to avoid delay in overall job progress.

C. Rejection of Work: Testing Agency may inspect and test materials at the source before shipment as well as at the site before, during or after installation in the Work. Construction Manager and Architect reserve the right, at any time before final acceptance of the completed Work, to reject material not conforming with specified requirements, regardless of previous tests, inspections, acceptances, or inclusion in certificates of payment.

D. Provisions for Other Work: The Work under this Section shall include required cutting, punching, drilling, welding and all else required for the attachment and the passing-through of other Work.

E. Construction Sequence: Descriptions of limitations on construction sequence are intended to assist Contractor in coordinating the Work of the Project. Descriptions do not describe fully the limitations given, do not describe all limitations, nor do they preclude construction sequences not contemplated herein. Whether or not Contractor follows the limitations on construction sequence described herein, and until such time as the structural work is completed, Contractor remains fully responsible for both the stability and the safety of the Work; adherence to the limitations described herein does not relieve Contractor from that responsibility.

1. Generally, the structure is to be constructed from the bottom to the top, floor-by-floor, with Contractor supplying such temporary bracing and shoring as may be required to compensate for the lack of completion of portions of the construction.
2. Plan and accomplish construction sequence in accord with Structural, Architectural, Mechanical, Electrical and all other Drawings forming a part of the Work.
3. Sealing of Erection Drawings by Contractor's Professional Engineer shall include and imply a full review of construction sequence and of related operations. Alternatively, Contractor shall submit a letter bearing the seal and signature of Contractor's Professional Engineer attesting to conformance with this requirement.

F. Construction Loads: The structure is designed to resist safely the loading prescribed by *Building Code* for the finished building. No provision is included for loads or stresses imposed or induced by Contractor's means and methods of construction. Design loads are provided in *Building Code* but are sometimes modified upward as provided in Structural Engineer's Design Criteria.

1. Where Contractor elects to place loads on the structure or elects to otherwise load or deform the structure in excess of the design loads, Contractor shall submit drawings and supporting calculations prepared under the supervision of and sealed by Contractor's Professional Engineer.
a) Review of Contractor's submittal shall not relieve Contractor from full responsibility for Contractor's means and methods of construction.
2. Alternatively, Contractor may seek professional services from Structural Engineer. Such services may be obtained through Owner or, with the permission of Owner, may be obtained directly from Structural Engineer. Architect will not be involved contractually in any such services.

G. Accidents and Hazardous Conditions: Contractor shall prepare a detailed written report of all accidents and other occurrences involving death, significant personal injury and/or significant losses in tangible property and shall submit the report promptly.

H. Installing and Rigging Equipment: Contractor shall shore all construction susceptible to impact loading from the installation of equipment installed by other trades.

1. Such equipment shall include but shall not be limited to boilers, chillers, refrigeration equipment, pumps, transformers, elevator machines and the like.
2. Remove shoring when equipment installation is complete.

I. Quantities: Contractor's bid shall be for all Work. Apparent omissions or conflicts in the Documents shall be reported at the time of discovery. In the event that information is missing from schedules or that identifying marks are missing from structural members as given in Drawings, Contractor will be compensated for steel quantities only where in excess of the following quantities:

Item	Formula	Unit	Where
Beam	2.5xS	lb/ft	S = Span (ft.)(m)
Girder	0.25xSxB	lb/ft	B = Tributary width (ft.)(m)
Column	0.03xNxA	lb/ft	N = Number of floors above column
			A = Tributary area per floor supported by column (s.f.)(m^2)
Beam	12xS	kg/m	
Girder	4.0xSxB	kg/m	
Column	0.48xNxA	kg/m	

1.11 DEFICIENT WORK

A. Repairing, Patching, Cleaning: Contractor shall correct all deficiencies in the Work of this Specification, including areas where Testing Agency reports, or Construction Manager's or Architect's rejections have indicated that Work is not in full compliance with the Contract Documents. Perform, at no expense to Owner, all additional tests that Construction Manager or Architect deem necessary to reconfirm noncompliance of the original Work and perform, at no expense to Owner, all tests and inspections which may be necessary to show compliance of corrected Work.

B. Defective and Nonconforming Work: Defective Work, unsuitable Work or Work otherwise failing to conform to the Contract Documents shall be made good by Contractor at no change in the amount of the Contract. Contractor shall prepare appropriate details and procedures for bringing such Work into conformance with the Contract Documents and shall submit such details and procedures for acceptance. Corrective Work, including materials, shall conform strictly to accepted details and procedures. Nonconforming Work may be rejected at any time, regardless of prior acceptance in Shop Drawings, prior inspection, inclusion in inspection or test reports, or inclusion in certificates of payment.

C. Deficiencies: Where Work exhibits any one or more of the following Deficiencies, or where Work otherwise fails to conform to the requirements of the Contract Documents or to the requirements of *Building Code*, for any reason or combination of reasons, such Work shall be considered Deficient and not in conformance with the requirements of the Contract:

1. Bent, twisted, buckled or warped pieces.
2. Unauthorized cutting, reaming and so forth.
3. Materials or workmanship not in accord with the Drawings, with the Specifications, with accepted samples, or with referenced codes or standards.
4. Cracking, interior or surface defects and the like.
5. Exceedance of tolerances.
6. Painted, unpainted or galvanized surfaces not sufficiently clean to provide full bonding of spray fireproofing, paint or other coatings.

7. Tops of flanges not sufficiently clean to receive field-applied stud shear connectors or deck welding.
8. Post-installed anchors not set in accordance with Manufacturer's Printed Installation Instructions, adhesive anchors not set with insufficient adhesive (no overfill visible).

D. Replacement or Repair: Where Construction Manager or Architect, at its sole discretion, finds any deficiencies or other Work not in accord with the requirements of the Contract Documents, Construction Manager or Architect may order that the affected Work be replaced or repaired at Contractor's expense.

1. Contractor shall reimburse Owner for the actual amount of the fees of Testing Agency for the reinspection and the retesting of Work deemed defective by Construction Manager or by Architect.

E. Cost: The cost of all other activities and procedures associated with defective Work shall be paid by Contractor.

1.12 PART-TIME PARTICIPATION - SURVEILLANCE ENGINEER

A. Surveillance Engineer: From time-to-time Structural Engineer may provide at the construction site, or at the fabrication works, the services of a Surveillance Engineer taken from its New York office. Principal responsibilities of Surveillance Engineer will be as follows:

1. Endeavor to provide further assurance that structural Work is accomplished in accordance with the requirements of the Contract Documents.
2. Assist in the expeditious removal of obstacles to the progress of the Work.

B. Structural Engineer's Surveillance Engineer will not be authorized to:

1. Personally conduct or direct the performance of tests, but will witness and will advise on such tests where appropriate.
2. Authorize deviations from the Contract Documents without prior written consent of both Owner and Architect.
3. Assume any of the responsibilities of Contractor; for example, Surveillance Engineer may not advise formally or informally on any aspect of construction means, methods, techniques, sequences or procedures, of safety precautions and programs in connection with the Work.
4. Accept Shop Drawings or samples without special permission from Structural Engineer's office in New York.
5. Approve or issue a Certificate of Payment, a Change Order, or issue verbal instructions which modify the Contract between Owner and Contractor.

C. Activities of Surveillance Engineer: The activities of the Surveillance Engineer do not constitute either inspection or acceptance of the Work, nor shall they be construed to relieve Contractor from full responsibility for the means and methods of construction or for safety on the construction site.

PART 2 - PRODUCTS

2.1 GENERAL

A. Structural Steel furnished for each location shall provide the minimum yield point given in the Drawings, shall conform to the applicable ASTM Steel Specification, shall meet the requirements of *Building Code*, shall be suitable for use in welded structures and shall meet the requirements both of the Drawings and of this Specification. All material shall be new and of best commercial quality. Steels produced to modified ASTM Specifications shall not be used without written acceptance. Except where specific products are given in the Drawings or in this Specification, structural steel used in the Work may be chosen by Contractor from the applicable specifications listed in *AISC Specification* and accepted by both *Building Code* and by governing agencies having jurisdiction.

1. Contractor, in ordering materials from manufacturers and vendors, shall ensure that the manufacturer or vendor understands fully the intended use of the as-fabricated and as-erected Work. Provide manufacturers and vendors with a full copy of this Section. Purchase orders shall identify the end use of purchased materials.
Examples of end use include:
a) built-up member flanges and webs
b) columns
c) tension members
d) elements of rigid frames
e) all elements identified specifically in Drawings
f) all special and sensitive areas of the Work
Particular care shall be taken to identify materials:
g) stressed in tension transverse to the grain (rigid frames, trusses, etc.)
It is the intent of these provisions to assist producer in the selection of materials best suited for the intended purpose.

2. Unless noted specifically as not carrying tensile loads or detailed as bolted, all steels and products selected for use in the Work shall be suitable for use as tension members, connected by welding.

2.2 MATERIALS

A. Welding Materials shall be as required by *Building Code* and by AWS for the conditions of intended use and for the metal being welded. Provide welding materials with as-welded Charpy V-Notch impact values of not less than 20 ft-lb at 0°F (27 N-m @ -18°C). Welding materials shall conform to the base metal/filler metal combinations listed in the AWS Specifications and Table 2.2-1 and to the filler metal classifications listed in Table 2.2-2, except where other welding material or material combinations and related welding processes are accepted.

TABLE 2.2-1				
Base Metal Yield	Filler Metal Classifications			
	SMAW	SAW	GMAW	FCAW
Up to & Incl. 50 ksi	E70 (E480)	F7 (F48)	ER70 (ER480)	E7 (E48)
60 ksi & 65 ksi	E80 (E550)	F8 (F55)	ER80 (ER550)	E8 (E55)
70 ksi & greater	E90 (E620)	F9 (F62)	ER90 (ER620)	E9 (E62)

TABLE 2.2-2				
Base Metal	Welding Process	AWS Spec.	Filler Metal Classification	
Carbon Steel and Low Alloy Steel	SMAW	A5.1	E7018	
		A5.5	E8018-C3, E9018-D3	
	SAW	A5.17	F7A2-EXXX	
		A5.23	F8A2-EXXX, F9A4-EXXX	
	GMAW	A5.18	ER70S-6, ER70S-2	
		A5.28	ER80S-D2, ER90S-D2	
	FCAW	A5.20	E71T-8, E71T-1, E70T-1, E70T-6	
		A5.29	E71T-8Ni1, E81T1-Ni1, E91T1-Ni2	
Stainless Steel			(Type 304)	(Type 316)
	SMAW	A5.4	E308L	E316L
	SAW	A5.9	ER308L	ER316L
	GMAW	A5.9	ER308LSi	ER316LSi
	FCAW	A5.22	E308LT	E316LT
Stainless Steel to Carbon Steel	SMAW	A5.4	E309L	
	SAW	A5.9	ER309L	
	GMAW	A5.9	ER309LSi	
	FCAW	A5.22	E309LT	

Welding electrodes which have been dampened or which have been contaminated by grease or other substances deleterious to welding shall not be used in the Work.

B. Shielding Gas shall be of a welding grade having a dew point of -40°F (-40°C) or lower.

C. High Tensile Bolts, Tension Control Fasteners, Nuts, DTI's and Washers shall conform to the applicable ASTM specification shown in Table 2.2-3.

TABLE 2.2-3			
Bolts	Nuts	DTI's	Washers
ASTM A325 (Type 1), ASTM F1852 (TCF), and ASTM A490 (Type 1)	ASTM A563 (DH)	ASTM F959	ASTM F436

NOTE: Neither A490 Type 2, A490 Type 3, nor A325 Type 3 shall be used in the work.

All fastener components shall bear the manufacturer's mark; nuts shall bear the DH symbol. Sleeve nuts, clevises and the like shall develop the full strength of the threaded rod or bolt. All bolts, nuts and washers shall be cold forged; bolts shall have rolled threads. Neither hot forged bolts or nuts nor cut threads may be used in the Work.

1. In addition to the mandatory testing provided in the ASTM specification, proof load testing (ASTM F606), chemical analysis (ASTM A751) and certification shall be required of manufacturer; for galvanized bolts, nuts and washers, manufacturer's certification shall include the results of the rotational-capacity tests as well as the results of the zinc thickness measurements. Except for the rotational-capacity tests of galvanized bolt, nut and washer assemblies, which shall be performed in accord with the Shipping Lot Method, all testing and analysis shall be conducted in accord with the Production Lot Method. Testing shall be completed for each grade of each type of each size of fastener. Fastener components not in full conformance to the appropriate ASTM specification shall not be shipped to the Work.
   a) Proof load testing shall be conducted on full-size bolts and components not on machined test specimens.
   b) Proof load testing shall be accomplished using Method 1 (Length Measurement) of Method F606.
   c) Testing shall include both hardness and tensile strength.

2. Bolts, nuts and washers shall be manufactured by a member of the Industrial Fasteners Institute.

3. Accepted manufacturers are:
   a) LeJeune Bolt Company
   b) Infasco
   c) Nucor Fastener
   d) Unytite
   e) Lohr Structural Fastener
   f) Other where accepted.

4. Mechanical galvanized bolts, nuts, washers, DTI's and inserts, as applicable, conforming to ASTM B695, Class 50 shall be used at all surfaces containing galvanized materials and at all surfaces exposed to ambient temperature. Galvanizing shall be undertaken only on A325, Type 1 bolts, ASTM A563 DH nuts, ASTM F959 DTI's, and F436 heat treated washers. ASTM F1852 tension control fasteners shall not be galvanized by any process.

5. Beveled washers shall be square, smooth, and shall be sloped to provide contact surfaces in full bearing. Provide for all slopes of 1:20 and larger.

6. The diameter of holes in special, beveled and square washers shall not exceed 1/16" (1600 □m) more than the nominal bolt diameter.

7. Thread Lubrication shall conform to bolt manufacturer's written recommendation. All galvanized A563 nuts shall be provided with an additional lubricant that shall be clean and dry to the touch and have a color that contrasts with the zinc coating so its presence is visually obvious. Galvanized structural bolts shall be Rotational Capacity Tested in accordance with the provisions of ASTM A325, and a record of such tests for each lot shall be submitted to the Structural Engineer.

D. Bolt Tension Indicating Devices shall be direct-tension indicating washers (DTI) or tension control fasteners (TCF).

1. Direct-tension indicating washers shall be of domestic manufacture, containing only domestically produced raw materials, conforming to the latest revision of ASTM F959. No 'squirt-type' DTI's are to be used, nor DTI's with slots cut in the back. Accepted manufacturers are TurnaSure LLC, Bethfast Inc., or other where accepted. Provide mechanically galvanized (ASTM B695, Class 50) washers for all surfaces and assemblies containing galvanized materials.

2. Tension control fasteners shall conform to the latest revision of ASTM F1852 for the A325 strength level, and to the applicable provisions of ASTM A490 Type I as well as the provisions of Section 2.8 of the RCSC Specification pertaining to Alternative-Design Fasteners. Accepted manufacturers are LeJeune Bolt Company, Infasco, Vermont Fasteners Manufacturing, or other where accepted.

a) Neither A490 Type 2, A490 Type 3 nor A325 Type 3 shall be used in the Work.

E. Unfinished Bolts shall be ASTM A307, Grade A, regular low carbon steel hexagonal heads and nuts.

1. Nuts for ASTM A307 bolts shall be ASTM A563, Grade A (heavy hex for bolts larger than 1 1/2 inch diameter) nuts installed with thread locking compound, ESNA elastic stop nuts by McLean-Fogg or SPS Technologies, or other accepted nut.

2. Washers for A307 bolts shall conform to American Standard B18.22.1, Type B or to ASTM F436.

F. Stainless Steel shapes, plates, fasteners, washers and the like shall be Type 18-8 conforming to AISI Grade 304 or 316.

1. Stainless steel bolts shall conform to ASTM F593, Group 1 or 2, Condition SH or CW. Accepted manufacturers are Robbins Manufacturing or other where accepted.

2. Stainless steel nuts shall conform to ASTM F594, Group 1 or 2, Condition SH or CW. Accepted manufacturers are Robbins Manufacturing or other where accepted.

G. Anchor Bolts: May be of uncoated steel unless otherwise required by the Drawings, by *Building Code* or by governmental authorities having jurisdiction. Unless otherwise provided in the Drawings provide 1 inch (25 mm) diameter or larger.

1. Unless otherwise given, provide as follows:
a) Bolt material conforming to ASTM A36 FY 36 (245 MPa).
b) Two heavy hex nuts as specified for *ASTM A325*.
c) 3 x 3 x 3/8 (75x75x10 mm), FY 36 (245 MPa) plate washer.

2. Where designated A449, provide as follows:
a) Bolt material conforming to ASTM A449.
b) Two heavy hex nuts as specified for *ASTM A325*.
c) 3 x 3 x 1/2 (75x75x12 mm), FY 50 (345 MPa) plate washer.

H. Post-Installed Mechanical Anchors shall be either expansion or undercut type. Where substitutions are requested, the alternate anchor shall be similar in type to that specified in the Contract Documents and be designed in accordance with substitution requirements.

1. Standard Wedge-Type Expansion Anchors:
a) Kwik Bolt 3 and TZ, by Hilti Corp.
b) Power-Stud+ SD1 and SD2, by Power Fasteners Inc.
c) Strong-Bolt 2, by Simpson Stront-Tie
d) Other where accepted

2. Heavy-Duty Wedge-Type Expansion Anchors:
a) HSL 3 Heavy Duty Sleeve Anchor, by Hilti Corp.
b) Power-Bolt, by Powers Fasteners Inc.
c) Other where accepted

3. Undercut Expansion Anchors:
a) HDA Undercut Anchor, by Hilti Corp.
b) Atomic+, by Powers Fasteners Inc.
c) Torq-Cut, by Simpson Strong-Tie
d) Other where accepted

4. Galvanizing shall conform to ASTM B 695, Class 50 or to ASTM B 633, SC1.

5. Stainless steel for studs and washers shall conform to AISI Grade 304 or Grade 316 and to ASTM F 593, Group 1 or Group 2, Condition SH. Nuts shall be of stainless steel conforming to ASTM F 594, Group 1 or Group 2, Condition SH.

I. Post-Installed Adhesive Anchors shall be either acrylic or epoxy, injectable type. Where substitutions are requested, the alternate adhesive shall be similar in type to that specified in the Contract Documents and be designed in accordance with substitution requirements.

1. Acryllic or Vinylester Adhesive:
a) HY200, by Hilti Corp.
b) AC100+ Gold, by Powers Fasteners Inc.
c) Other where accepted

2. Epoxy Adhesive:
a) Hilti RE 500 V3, by Hilti Corp
b) PE1000+, by Powers Fasteners Inc.

c) SET-XP, by Simpson Strong-Tie
d) Other where accepted

3. Galvanizing shall conform to ASTM B 695, Class 50 or to ASTM B 633, SC1.

4. Stainless steel for studs and washers shall conform to AISI Grade 304 or Grade 316 and to ASTM F 593, Group 1 or Group 2, Condition SH. Nuts shall be of stainless steel conforming to ASTM F 594, Group 1 or Group 2, Condition SH.

J. Thread Locking Compound shall be Loc-Tite 242 or 243, as appropriate, by Loctite Corporation, or other accepted compound.

K. Steel Deck Support Shelves: Provide angles of 5/16 inch (8 mm) minimum thickness and 3 inch (75 mm) minimum width except where different shapes or dimensions are accepted.

L. Gratings shall be proportioned to resist safely the superimposed loads.

1. For trench cover, see drawings.

M. Shop and Field-Applied Paint shall be provided where designated in the Drawings, specified herein, and where required by *Building Code*. Paint materials shall be fully compatible with fireproofing and other materials in contact with the paint and shall be selected from the following:

1. Alkyd Modified Shop Primer and Field Touch-Up:
a) Carbocoat 150 Primer, by Carboline Inc.
b) Dulux Alkyd Primer 681-FD, by DuPont Co.
c) Tnemec Primer 10-99, by Tnemec Company Inc.
d) Other where accepted

2. Zinc-Rich Shop Primer:
a) Carbozinc 11 HS or Carbozinc 859, by Carboline Inc.
b) Ganicin 347-Y-931, by DuPont Co.
c) Tneme-Zinc 90-96 or Tneme-Zinc 90-97, by Tnemec Company Inc.
d) Other where accepted

3. Zinc-Rich Field Touch-Up:
a) Carbozinc 859, by Carboline Inc.
b) Ganicin 347-Y-937, by DuPont Co.
c) Tneme-Zinc 90-97 by Tnemec Company Inc.
d) Other where accepted

4. Where aluminum alloy is in contact with or fastened to steel members, the aluminum shall be kept from direct contact with the steel by painting the steel with a dielectric separator such as Bitumastic 50 by Carboline Inc., or other where accepted.

N. Galvanized Steel: Where required to be galvanized, members shall be hot-dipped after fabrication in accordance with ASTM A123 or with ASTM A153, as applicable. Galvanizing shall equal or exceed 2 oz. per square foot (600 g/m^2) of surface.

O. Galvanizing Repair Paint: Provide organic, zinc-rich paint that contains at least 90% zinc particles in the dried film. Galvanizing paint shall comply with either ASTM A-780, Federal Specification DOD-P-21035 or Military Specification MIL-P-26915.

1. Brite Zinc, by Brite Products
2. ZIRP, by Duncan Galvanizing Corp.
3. ZRC Cold Galvanizing Compound, by ZRC Products Company
4. Other where accepted

P. Weldable Primer shall be used for the protection of beveled surfaces to be complete penetration or partial penetration welded in the field. Weldable primer is also acceptable for the protection of milled surfaces used in bearing connections. Acceptable primers are CarboWeld 11 HS by Carboline, Deoxalumite by AACO, or other accepted weldable primer.

PART 3 - EXECUTION

3.1 CONTRACTOR'S INSPECTION

A. Examination of Field Conditions: Examine all surfaces, features and facilities to which Work must be attached or applied, abut or clear. Notify Construction Manager and Architect in writing of all conditions which are or will be detrimental to proper and expeditious installation of Work. Starting of Work shall represent acceptance by Contractor of surfaces and of conditions as suitable and correct for performing Work as specified.

B. Field Measurements: Contractor shall verify, by measurements at the jobsite, all dimensions affecting the Work of this Section. Field dimensions at variance with those in accepted Shop Drawings shall be reported in writing by Contractor. Decisions regarding corrective measures shall be subject to acceptance and acceptance shall be obtained before starting fabrication of items affected. The starting of Work shall represent acceptance by Contractor of all dimensions affecting the Work of this Section as suitable and correct for the performing of all Work under this Section.

3.2 FABRICATION

A. Structural Steel shall be shop fabricated in strict accord with Shop Drawings, certificates, and other accepted data. All Work shall conform to the applicable Standard as given herein and as need apply to the Work. Workmanship shall be of the best practice of relevant trades and shall be performed by skilled mechanics making use of modern tools and equipment in good condition. To the extent practical, Work shall be accomplished in the shop and not in the field.

B. Material Delivery Tolerances: While ASTM A6 and A20 are acceptable delivery tolerances for mill material, Contractor shall straighten, square, flatten and torsionally align plates and shapes as necessary to provide fabricated elements within allowable tolerances as well as to provide correct alignment, good fit and uniform erection clearance, as applicable.

C. Cleaning and Straightening: Prior to fabrication or Work, all steel shall be examined for confirmation to the delivery tolerances. All out-of-tolerance conditions shall be corrected prior to fabrication by making use of techniques accepted under this Specification. Steel shall then be cleaned by blasting and/or wire brushed so as to remove all loose mill, scale and rust.

D. Camber and Sweep: Except where specific camber or sweep is designated in the Drawings, beams shall be fabricated with natural camber up. Provide spandrels and beams adjacent to openings with the natural sweep inward (toward the building and away from immediately adjacent openings). Designated camber shall provide actual camber in the erected steelwork within camber tolerances set forth in AISC Manual (for rolled shapes) and in AWS D1.1, Chapter 5.23 (for built-up shapes).

E. Finishing shall mean milled to ASA 250 or smoother, unless another finishing method is both designated in Shop Drawings and accepted. Finished surfaces shall be protected by a corrosion inhibiting substance. Finish contact surfaces of grillages, base plates, column splices, where indicated "fit to bear", and at other locations where indicated in Drawings.

F. Gas Cutting: Gas cutting, including miscellaneous cuts, copes, cuts for weld access and the like, shall provide smooth, uniform, workmanlike surfaces and shall achieve a 1000 micron surface roughness or better as defined by ANSI/ASME B46.1. Except where accepted, gas cutting shall be machine guided; cutting by hand-guided tools will require grinding. Provide 1/2 inch (13 mm) minimum radius cut at all reentrant corners except where a smaller or larger radius for specific details is shown or noted in the Drawings or specifically proposed by Contractor and accepted in Shop Drawings. Gas cut surfaces shall be made uniform and notch-free by chipping, planing, welding and grinding as required, and shall be verified by Contractor by full visual inspection; where hand-held cutting tools are used, and where required by *AISC Specification*, Contractor shall provide 100% inspection by liquid-penetrant or by magnetic particle.

1. Galvanized Members: Gas-cut surfaces at reentrant corners shall be ground to bright metal and tested by dye-penetrant or magnetic particle testing prior to galvanizing, and shall be verified by Contractor by full visual inspection after galvanizing.

G. Straightening: Fabricated materials containing sharp kinks or bends shall be rejected. Material straightened prior to fabrication shall be examined carefully for signs of distress and for other defects before being placed in fabrication. Distressed or otherwise defective material shall not be used in the Work. Straightening by the use of properly controlled heat will be permissible if done by personnel skilled in heat straightening, using equipment and techniques in accord with written procedure documents and applicable detail sketches prepared by the Fabricator and accepted.

1. Follow procedures provided under AWS D1.1.
2. Fuel shall be propane and oxygen.
3. Temperature may not exceed 1200°F (650°C) - a dull red color - or limits specified for quench and tempered steels, as applicable.
   a) Control with Tempilstick or Thermomelt Stick for 1000°F (550°C) to 1200°F (650°C) range.
   b) Single burner torches shall be used.
4. Air cool at ambient temperature.
   a) Water cooling shall be used only with written permission.
5. All welds in straightened material shall be reinspected by Contractor, by UT or MT as appropriate.

H. Grinding: Sharp corners, projections, and similar rough or sharp surfaces or edges shall be eased and smoothed by grinding so as to provide notch-free surfaces.

I. Preheat: Welding shall be performed on material preheated to a temperature above the dewpoint, regardless of other preheating requirements. Preheat for welding shall be soaked preheat and shall be verified by heat sensitive crayons (Tempilstik, by Tempil, Inc.) or other accepted means.

J. Welding Materials and processes shall be selected from those specified herein and shall conform to accepted welding procedure specifications. Welding materials shall be fresh and new. Welding electrodes or flux contaminated by deleterious substances or moisture shall not be used and shall be removed promptly from the Work. Low hydrogen electrodes which cannot be used promptly after opening of hermetically sealed containers shall be stored in electric holding ovens at 250°F (120°C) minimum. Electrodes or flux which have been dampened or contaminated shall be removed promptly from the Work.

K. Tack Welds: Exercise the same degree of control in making tack welds as required for structural welds, including provision of preheat and postheat appropriate to the basemetals joined. Tack welds which crack shall be cut or ground and damaged base metal repaired. Remove and grind smooth tack welds not incorporated into permanent structural welds.

L. Arc Strikes: Stray arcing between electrodes or other portions of the welding system and base metal locations outside structural welds shall be avoided to the maximum extent practicable. In those locations where arc strikes do occur, the affected base metal shall be ground smooth, or otherwise repaired, to remove the effects of the arc strike and ensure continuing soundness of the base metal.

M. Shop Bolting with ASTM A325 or ASTM A490 bolts shall conform to applicable provisions of the *AISC Specification* and *Specification for Structural Joints Using ASTM A325 or* A490 *Bolts* except that all bolting provisions set forth in ERECTION of this Section shall apply to high-strength shop bolting.

N. Drainage Holes: Provide hollow tubular, box and other members with effective drainage holes except where members are sealed tight at Contractor's option or in accord with notes and details included in the Drawings. Structural Steel Sub-Contractor is fully responsible to provide steelwork free of entrapped water at the completion of the project.

O. Beam Openings: Provide openings as shown, noted or scheduled in the Drawings. Provide holes, slots and openings required for passage of Work of other trades together with necessary reinforcing. Use suitable templates for accurate location of openings. Where openings are shown in the Drawings or in Shop Drawings, changes in location will not be permitted except where accepted specifically. Beam openings not shown or scheduled shall be provided only where accepted specifically.

P. Steel Deck Support Material shall be shop welded to structural steel except where field welding is necessary to provide required erection sequences.

Q. Bolt Holes: Drill or punch holes at right angles to the surface of the metal. Provide holes not more than 1/16 inch (1500 □m) larger than the connector diameter unless oversize or slotted holes are shown or noted in the Drawings or specifically accepted. Do not make or enlarge holes by burning. Drill or sub-punch and ream material where thickness exceeds the connector diameter and in all material thicker than 7/8 inch (22 mm). Holes shall be true and fair without torn or ragged edges. Elongated punch and die sets shall be used to punch elongated holes. Burrs shall be removed.

R. Quality of Welds and Base Metal: Quality of all welds shall conform to AWS D1.1, Chapter 6 - Part C. When examined by UT, partial and complete penetration welds shall conform to AWS D1.1, Chapter 6 statically loaded acceptance criteria. Unless otherwise noted, welds shall be assumed to be subjected to tension stress normal to the weld axis. Cracking or incomplete penetration shall be cause for rejection of each weld possessing such defects, regardless of other acceptance or rejection criteria. Base metal containing gross discontinuities before or after welding or lamellar tearing after welding shall be repaired in accord with procedures accepted by Structural Engineer or shall be discarded and replaced.

1. Provide material thickness and width transitions in accord with details in the Drawings where shown, and in accord with the provisions of AWS D1.1, Article 2.29.

2. Provide weld access holes or cuts in accord with details shown in the Drawings, the provisions of AWS D1.1, the provisions of the *AISC Specification* and the gas cutting provisions of this Specification. Plug access holes with defect-free base metal and weld metal where sealed members are required.

S. Brittle Fracture Contractor shall take all measures necessary to minimize the occurrence of brittle fracture. Measures shall include proper materials selection, fabrication techniques and the like.

1. Both base metal and welding materials shall provide adequate notch toughness.
2. Stress concentrations shall be minimized by carefully controlling notches and by controlling weld defects such as lack of fusion and cold cracking. Stress relief holes shall be provided at all welded web-to-flange interfaces for shapes with flange thickness in excess of 1.0 inches (25 mm).
3. Welds, including multiple-pass welds shall be completed in a single operation, without interruption.
4. Cooling rates and non-uniformity of cooling of welds shall be reduced by proper insulating blankets and, where necessary, by post-heating.
5. Excessive elevation of welding temperatures shall be avoided. Practices such as the simultaneous welding of both sides of a stiffener within the bosom of a wide flange shape shall not be allowed.
6. Provide and then remove run-on and run-off tabs at all locations where start-up or termination portion of weld may create a stress raiser.
7. Particular care shall be taken to eliminate cold cracking.
a) Pre-heat and post-heat conditions shall be provided not less than as required per AWS D1.1.
b) Welding electrodes are assumed to be of the low hydrogen type, thoroughly baked, and that rust and oil in welding grooves is not present. Note that sufficient pre-heating, with lower heating rate and wider pre-heated zone is required in order to keep interpass temperatures above minimum values, particularly where heavier sections are being welded.
c) Weld cooling rate shall be controlled so as to reduce residual stresses caused by welding and to enhance hydrogen evolution.
d) Welding at ambient temperatures below 32°F (0°C) shall not be accomplished without prior acceptance.
8. Take special care to grind copes, access holes and other cuts so as to improve the surface and to reduce the potential for notch formation.

T. Weld Inspection: Contractor shall inspect 100% of shop and field welds to assure that all welding conforms to the requirements of Contract Documents. Governing documents include, but are not limited to this Specification, Contract Drawings, *Building Code* and ANSI/AWS D1.1, D1.3, and D1.4. All inspections shall assume that welds are in tension, with direction of stress in most critical direction (for example, transverse to undercut).

U. Runon and Runoff Tabs shall be removed and the surface made smooth prior to visual and non-destructive testing and prior to shipping Work to the site. Tabs for field welds shall be removed at all locations where required or directed.

V. Clean, Paint and Galvanize steel as provided herein. Do not paint steel except where provided specifically herein or in the Drawings.

W. Weep Holes: Where open members (such as wide flange shapes or channels) are positioned on their sides with flanges up, capable of holding water, provide weep holes as shown in the drawings or as specified. Unless otherwise noted, provide 1/2 inch (12 mm) diameter weep holes at 10 feet (3 meters) o.c., but not less than three 1/2 inch (12 mm) diameter weep holes per piece: one weep hole at each end, and one at midspan.

3.3 ERECTION

A. Erection of steelwork shall be performed by skilled workers in accord with the accepted Shop Drawings and certificates and shall conform strictly to the Contract Documents.

B. Surveys: Contractor shall employ a Professional Engineer or Professional Surveyor licensed in the project's jurisdiction and experienced in surveying steel building frameworks to oversee all survey work. Contractor shall organize structural steel surveying procedures and records to demonstrate the degree of conformance of the steelwork to tolerances applicable to plumb, level, horizontal alignment and allowable displacement from theoretical elevation. Contractor shall report all discrepancies. Contractor shall not proceed with each erection step until appropriate acceptable corrections have been made, or until compensating adjustments to the structural steelwork have been accepted. Contractor's surveys for steelwork shall:

1. Establish permanent bench marks as shown and as necessary for the accurate erection of structural steel;
2. Assure that elevations of bearing surfaces, and locations of anchor devices are checked by accurate surveying before erection work proceeds.
3. Provide survey data during the course of the Work and a final survey showing the E-W, N-S and elevation position of the work points of each steel frame, truss, column and other major member as compared to theoretical location.
4. Take surveys and measure tolerances and plumbness at 68°F (20°C) or show corrections to surveys where temperature is either higher or lower.

C. Anchor Bolts and Other Connectors: Furnish anchor bolts, embedded plates and other connection materials which must be embedded into concrete Work, for placement under Section 03 30 00. Deliver to the site on-time and complete with templates and placing drawings. Tighten nuts in a manner consistent with the intent and the metallurgy of the bolt material.

1. Unless otherwise provided, for bolts designated as A325 or Dywidag threadbars, tighten 1/4 turn past snug tight.

D. Base Plates, Bearing Plates and Grillages: Furnish and place base plates and bearing plates accurately. Securely shim, level and align. Be responsible for maintaining steel in proper position through completion of grouting and until grout has achieved full strength. Non-shrink grout will be furnished and placed under Section 03 30 00. Do not allow grouting until beams, girders, trusses and so forth are permanently attached to column.

E. Guying and Bracing: The structural system may require temporary bracing in addition to members shown in the Drawings in order to resist safely all imposed loads during construction and to maintain correct alignment. Provide temporary guying, bracing and connecting members where needed to resist safely all possible combinations of construction and erection loads including dead loads, erection loads, wind and other lateral loads and superimposed construction loads, both horizontal and vertical. Remove temporary members and connections after permanent members are in place, final connections are made and concrete has achieved design strength. Design of temporary shoring, bracing and guying is Contractor's sole and complete responsibility, including all details of installation and removal, methods, sequence and timing. Contractor's Professional Engineer shall design and supervise the adequacy, installation and removal of temporary bracing.

F. Bolt Tensioning: ASTM A325 and A490 bolts shall be installed using one of the following systems:

1. Tension controlled fasteners with splined twist-off nubs (TCF) shall be installed in accord with *AISC Specification* requirements and with applicable printed instructions and recommendations provided by the fastener manufacturer and tensioning system supplier. To provide uniform and full tensioning in multi-bolt joints, bolts shall be tightened in stages to assure uniform contact between faying surfaces and snug-tight condition at all points within each joint prior to final tensioning and shearing of the spline.

a) Tension controlled fasteners (TCF) shall be included in the base bid for ASTM A325 bolt sizes equal to and less than 1-1/8 inch (29 mm) in diameter.

b) Contractor shall check each TCF bolt after tensioning to verify that the sheared surface does not display any abnormality. Bolts displaying an abnormality shall be removed and replaced.

c) As an alternative, Contractor may include in his bid an add or deduct price for use of direct-tension indicating washers (DTI) on ASTM A325 bolt sizes equal to and less than 1-1/8 inch (29 mm) diameter.

2. Bolts 1 inch (25 mm) in diameter and larger and all ASTM A490 bolts shall be tensioned utilizing direct-tension indicating washers (DTI) in strict accord with ASTM F959. Under no circumstance may a DTI be reused. DTI washers shall not be used directly over slotted or oversized holes but shall be used in addition to all special washers required at slotted or oversize holes. Tensioning methods, number, thickness and type of washers, procedure and measurements shall be in strict accord with the manufacturer's latest printed instructions and recommendations and the latest requirements of the RCSC Specification.

a) Contractor shall verify correct tension by measuring the average residual gap between the bolt head or nut and the DTI in strict accord with ASTM F959. Torque wrenches or calibrated wrenches shall not be used to inspect or to verify the tension.

b) For bolts exposed to the weather, gaps in Type 325 DTI shall be reduced to less than 0.005 inches (130 □m) for not less than half of the perimeter of the DTI.

3. Filler beams may, at Contractor's option, be connected without making use of a tension control device but, if so, shall be tensioned by the “match marked” turn-of-the-nut technique. Filler beams do not frame to, or frame immediately adjacent to columns, do not frame to girders carrying columns, posts or hangers (except stair landing hangers), and do not frame to trusses.

4. Except where specifically waived in the Structural Drawings, all ASTM A325 and A490 bolts, whether or not used in bearing-type connections, shall be fully tensioned. This requirement shall be maintained whether or not required by *AISC Specification*.

G. Bolting Requirements: Contractor shall pay strict attention to the applicable codes and standards, to the requirements of this Specification and to the following general requirements:

1. Impact Wrenches used for tightening ASTM A325 and ASTM A490 bolts shall be in sufficiently good repair to dependably deliver the manufacturer's full rated torque. Air compressor(s) used to power impact wrenches shall be in good repair and shall be capable of delivering adequate air pressure and volume so that full rated performance is achieved from each wrench at the point of bolting. Air hoses and couplings shall be non-leaking. The impact wrench(es) selected shall tighten the bolts to not less than the minimum specified tension in thirty seconds or less.

a) For bolt sizes equal to or larger than 1 inch (25 mm) ASTM A325 and 7/8 inch (22 mm) A490, provide impact wrenches equivalent to or larger in capacity than a Chicago Pneumatic CP6120, with air pressure at the wrench not less than 100 psi (700 kPa).

2. Washers: A hardened washer shall be installed adjacent to the bearing face of the turned element (nut or bolt head) of each ASTM A325 or ASTM A490 bolt assembly. A 5/16 inch (8 mm) thick washer or thicker, otherwise conforming to ASTM F436, shall be used at both ends of 1-1/8 inch (28 mm) and 1-1/4 inch (32 mm) diameter A490 bolts connecting material with standard size holes where material is 5/8 inch (16 mm) or less in thickness.

3. Long Slotted Holes, where accepted, and where on an outside ply, shall be covered completely by 5/16 inch (8 mm) ASTM F436 hardened washers; alternatively, either plate washers or continuous bars of at least 3/8 inch (10 mm) thickness and minimum yield point of Fy = 50 ksi (345 MPa) may be used. Holes in plate washers or bars shall be standard size. Regular hardened washers are required in addition to plate washers or bars.

4. Short Slotted and Oversized Holes, where accepted, and where on an outside ply, shall be covered by ASTM F436 hardened washers, plate washers or continuous bars as provided for long slotted holes.

5. Bolts and Nuts, at time of tightening, shall be clean, rust-free, free from thread damage, and shall retain not less than the light residual coating of oil as received from the factory. Thread lubricants shall be applied to all ASTM A490 bolts or nuts, to all 1 inch (25 mm) and larger ASTM A325 bolts and to all bolts and nuts that display any sign of loss of residual oil, rust or other contaminant. Where galvanized nuts are not wax-dipped by manufacturer, apply thread lubricant.

a) Lubrication shall be completed prior to assembly and prior to being sent up into the Work, except that under no circumstance shall twist-off type tension-control fasteners be field lubricated.
b) In the event of a dispute regarding tightness of bolts installed in the field, cleanliness and lubrication of bolts and nuts used for verification tests shall be specifically representative of field materials and conditions.

6. Tightening Procedures: During tightening, to the full extent practical, the unturned bolt element shall be held without rotation. All plies shall first be brought into full contact by partially tensioning all of the bolts. Tensioning shall commence from the most rigid part of the connection, moving to the free edges.

7. Retightening: ASTM A490 bolts and galvanized ASTM A325 bolts, once completely or partially tensioned, shall not be reused. ASTM A325 bolts may be reused only with specific written acceptance.

8. Length: Bolts shall not project beyond the face of the nut by morethan three full threads. However, bolts shall at least be flush with the other face of the nut.

H. ASTM A307 Grade A Bolts may be used only where permitted by the Structural Drawings. Threads shall be precluded from the faying surfaces. Tighten using full manual effort on a suitable wrench so as to bring all surfaces into full bearing. Bolt head shall be tapped throughout the tightening process.

I. Unfair Holes shall not be enlarged by burning or drifting alone. Enlarge holes where necessary and permitted by flame piercing and reaming or by reaming alone or by other accepted means. Holes after enlargement shall be true round holes normal to the surfaces joined. Increase bolt size to fill enlarged and reamed holes, which shall then meet the requirements for “normal-sized” holes relative to the bolt size selected.

J. Faying Surfaces: Paint materials not specified as satisfying the mean slip coefficient for Class A surfaces as defined in the S*pecification for Structural Joints Using ASTM A325 or A490 Bolts* shall not be applied to faying surfaces.

K. Field Welding shall be performed only by properly licensed and certified welders. Welders shall wear on their helmets labels showing their AWS Qualification Number and shall carry at all times AWS identification/ certification cards. Pay strict attention to the need for welder to sign his/her name near welds which they have made. All welding provisions set forth in FABRICATION of this Section shall apply to field welding. Field welding shall be performed in accord with accepted procedure specifications. Field welds shall be subject to the same acceptance criteria as shop welds. Do not weld over a shop weld in the field unless the field weld is made with the same electrode and the same weld procedure as used in the shop.

L. Splices: Column splices and other compression joints that depend upon contact bearing after alignment shall conform with the following:

1. Bearing surfaces shall be cleaned before the parts are assembled.

2. Fastening of compression splices and joints shall be performed after the abutting surfaces have been brought uniformly into contact.

M. Permanent Connections: Structural members shall be permanently attached and made rigid only after all elements to be attached have been brought within the specified tolerances.

N. Field Fabrication, gas cutting and welding work shall conform to the applicable provisions of FABRICATION of this Section. Bent, kinked or deformed members may be rejected by Architect at its sole discretion. Such members may be straightened and corrected only in accord with accepted procedures. Gas cutting shall occur only where the metal being cut is not carrying stress, and provided stresses will not later be carried through a flame-cut surface.

O. Finger Tight: Bolts designated as "finger tight" shall be tensioned to 60 inch-pounds (6 N-m) with the goals of bringing the parts firmly together while allowing for a sliding connection. Provide thread locking compound at all such locations. Provide not less than two full cycles of torquing and untorquing to ensure that all bolts are properly tensioned.

P. Tolerances: Do not exceed tolerances provided under this Specification, *AISC Code*, *AISC Specification*, and AWS D1.1.

Q. Shims, where required to correct fit-up of Work, shall be free of corrosion and shall be of stainless steel.

R. Runoff and Runon Tabs shall be provided at the ends of all sensitive butt welds and both tabs and erection aids shall be removed at all locations where they interfere with the Work of other trades, and at all locations designated. Runoff tabs shall be not less than 1-1/4 inches (30 mm) in length.

S. Post-Installed Anchors shown in the Drawings, or accepted in writing, shall be installed in strict accord with Manufacturer's Printed Installation Instructions. Set perpendicular to concrete surface. Anchors may be placed in block or brick work only where voids within 9 inches (230 mm) of the anchor have been filled solidly, with grout. Drilled holes shall be cleaned thoroughly by compressed air or water jet. Holes in structural steel, intended to fit over post-installed anchors, shall be 1/16th inch (1500 □m) larger than the nominal diameter of the bolt except where larger or smaller holes are stipulated in the Drawings. Provide standard plate washer underneath Anchor Manufacturer’s provided washer.

T. Lock Nuts or Thread Locking Compound shall be used on all nuts not tensioned in accord with the specifications for ASTM A325 or ASTM A490 bolts and on all ASTM A307 bolts. Provide thread locking compound on A325 and A490 bolts only where allowed specifically in the Drawings; at other locations, use locking nuts as specified herein.

3.4 CLEANING, PAINTING AND GALVANIZING

A. General: Steel Work shall be cleaned, painted or galvanized as provided herein. Basic Work shall be done in the shop, with field touch-up, only, done in the field.

B. Corrosion Protection: This Specification contemplates 6 levels of corrosion protection:

1. Concrete-Encased/Unpainted: Steel Work shall be cleaned to meet the requirements of SSPC-SP2, by wire brush or other means at the option of Contractor. Reclean following erection to the extent required to achieve original condition.

2. Fireproofed/Unpainted: Steel Work shall be shop cleaned to meet the requirements of SSPC-SP3. Additional cleaning shall be accomplished in the field to ensure proper adherence of spray fireproofing.

3. Fireproofed/Shop Primed: Provide as for Fireproofed/Unpainted, but paint with shop primer with field touch-up, not less than 2.0 mils nor more than 4.0 mils dry film thickness (50 □m/100 □m). Provide only where shown specifically in the Drawings.

4. Shop Primed: Provide as for Fireproofed/Shop Primed.

5. Exposed to Ambient Temperature: Steel which is enclosed, concrete-encased or fireproofed, but which is not protected from changes in ambient temperature, shall be cleaned to meet the requirements of SSPC-SP6 before painting with a zinc-rich primer with field touch-up, not less than 2.0 mils nor more than 4.0 mils dry film thickness (50 □m/100 □m).

6. Exposed to Weather: Steel which is exposed to the weather including exterior lintels (except where stainless is required) shall be hot-dipped galvanized. Touch-up at welds and at damaged surfaces after first cleaning to SSPC-SP3, with slag and weld spatter removed first from all areas. Paint galvanized steel where shown in Drawings.

a) Provide galvanized bolts, nuts, washers, DTI's, and inserts, as applicable, for the bolting of galvanized members.

C. Paint shall be applied only to dry surfaces, only at times when steel surface temperatures are above the dew point, and shall be applied thoroughly and evenly without sags or holidays. Paint shall be applied by suitable spray equipment in strict accord with the paint manufacturer’s printed instructions. Provide a dry film thickness within the range specified herein, including around outside corners or other abrupt changes in surface profile.

D. Field Touch-Up shall be provided to field bolts of painted and of galvanized components and to all points of damage, including areas receiving weld after coating.

1. Unpainted surfaces shall be recleaned to the extent necessary to achieve sound tight bond of other Work.

2. Painted surfaces shall be cleaned and painted to the standards of the shop coating and touch-up so as to provide for workmanlike surfaces and for tight bond of other Work.

3. Galvanized surfaces shall be cleaned of slag and burned metal, by vigorous wire brushing and other tools, to base metal free from loose particles. Finish clean by solvents in accord with SSPC-SP1. Field-apply galvanizing touch-up to achieve quality of the original and undamaged shop coating.

4. Coat no-paint areas after completion of erection.

E. Contact with Aluminum: Surfaces which will be in contact with aluminum shall receive two coats of a dielectric separator over a shop-primed surface.

F. Handling, Shipping, Storing and Erection of Painted Steel: Contractor shall exercise handling means as well as shipping, storage and erection techniques to reasonably protect painted surfaces from damage, abrasion and soiling in order to minimize the need for touch-up painting after erection. Shop paint shall be adequately dry to withstand handling without damage prior to moving or loading steel elements for storage or delivery.

END OF SECTION 05 10 00

SECTION 05 30 00 - METAL DECK

PART 1 - GENERAL

1.1 CONTRACT DOCUMENTS

A. Comply with Contract Documents: All Work of this Section shall comply with the requirements of the Conditions of the Contract (General, Supplementary and Special), with all Sections of Division 1 - General Requirements, with this Section of the Specifications, with the Drawings and with all other Contract Documents.

B. Flammable Materials or materials not conforming in all respects to the fire resistive and fire safety provisions of governing regulations shall not be left in place in the Work.

C. Disposition of and Exposure to Materials: Contractor, remains fully responsible for the disposition of and for the exposure to persons of all materials, whether or not hazardous. .

D. Volatile Organic Compounds (VOC): Contractor remains fully responsible for the supplying of products and materials complying to the VOC limitations set forth by the *Building Code* and by governing agencies having jurisdiction.

1.2 WORK INCLUDED

A. Scope: Contractor shall examine all of the Contract Documents for the extent of the Work of this Section of the Specifications. That Work shall include all labor, materials, devices, plants, tools, equipment, appliances and services necessary to complete the Work as shown in the Drawings, as specified herein, as required by job conditions, and as required by governing authorities having jurisdiction, including but not limited to the following:

1. Metal deck as given in Drawings and as specified herein.
2. Flashing saddles, sumps, closure members, and cover plates at all edges, ends and intersections.
3. Metal flashing and closure plates around all columns and around the Work of other trades which penetrates the deck.
4. Hanger tabs and other devices for the vertical support of ceilings, and of light mechanical and electrical devices.
5. Cutting and forming of holes and openings through metal deck, including the reinforcing of deck to support safely both temporary and permanent construction.
6. Supports for metal deck not shown or specified or provided under other Sections of this Specification, but necessary for the proper, rigid and safe support of metal deck and of loads imposed thereon.
7. Corrosion protection, including field touch-up.
8. Shop Drawings, samples and submittals

9. All other labor, materials and Work given in the Drawings, specified herein or required to make the metal deck and stud shear connector Work complete.

1.3 RELATED WORK

A. Related Work Specified Elsewhere, Amplified Elsewhere or Included in Other Contracts:

1. Submittals: Section 01 30 00.
2. Owner's shop and field testing and inspection of metal deck and of stud shear connector Work by Testing Agency engaged and paid for by Owner: Section 01 40 00.
3. Masonry: Division 4.
4. Structural Steel: Section 05 10 00.
5. Painting: Section 09 90 00.

1.4 APPLICABLE CODES AND STANDARDS

A. General: Except as modified or voided by requirements specified herein or by details or notes included in the Drawings, Work specified under this Section shall conform to all applicable provisions of the codes, specifications, standards and other reference documents cited in this Specification and/or noted in the Drawings. In the event of conflict between provisions of stipulated reference documents and of this Specification or of another stipulated reference document, Contractor shall report in writing the details of the conflict. Decisions regarding applicability of provisions of this Specification and provisions of reference documents applied independently or as supplemented, modified or voided, will be provided in writing and shall be final. Resolution of conflicts shall conform to the procedures set forth in the General Conditions of the Contract.

B. Codes: All Work under this Section shall conform to the requirements of the 2022 Connecticut State Building Code, hereinafter referred to as *Building Code*, and to the regulations of all governmental authorities having jurisdiction. Where more stringent, the following codes, standards and specifications, latest edition and revision, shall apply to the Work, all as modified herein or by *Building Code*:

1. "*North American Specification for the Design of Cold-Formed Steel Structural Members"*, by the American Iron and Steel Institute (*AISI Specification*).
2. *Design Manual for Composite Decks, Form Decks, and Roof Decks*, by Steel Deck Institute.
3. *Specification for Structural Steel Buildings, AISC 360*, by the American Institute of Steel Construction (*AISC*).
4. *Code of Standard Practice for Steel Buildings and Bridges*, published by the American Institute of Steel Construction, Inc. (*AISC Code*). Sections 6, 7 and 8 only shall apply to the Work, except as modified in this Specification; the remainder being specifically excluded.
5. *Structural Welding Code - Steel*, AWS D1.1.
6. *Structural Welding Code - Sheet Steel*, AWS D1.3.

7. *Standard Symbols for Welding, Brazing, and Nondestructive Examination*, AWS A2.4.
8. Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding, AWS A5.1.

C. Reference Documents: To the extent that the best quality of Work is provided, Work shall conform to the examples, procedures and recommendations listed below, latest edition and revision. Where provisions of the, *Building Code* this Specification, or codes, standards, manuals and specifications cited by this Specification are more restrictive or provide increased quality, the combination of provisions, examples, procedures and recommendations which provide both best quality and *Building Code* conformance shall control the Work.
1. *Manual of Construction with Steel Deck*, by Steel Deck Institute.
2. *Standard Practice Details*, by Steel Deck Institute.
3. *Roof Deck Construction Handbook*, by Steel Deck Institute.
4. *Cold-Formed Steel Design Manual*, by the American Iron and Steel Institute.
5. *Diaphragm Design Manual*, by Steel Deck Institute.
6. *Manual of Steel Construction Allowable Stress Design*, Ninth Edition, by the American Institute of Steel Construction (*AISC Manual*).
7. *Manual of Steel Construction, LRFD*, by the American Institute of Steel Construction (*AISC Manual*).
8. "*Steel Structures Painting Manual*", Volume 1 and Volume 2, by Steel Structures Painting Council.

D. ASTM (American Society for Testing and Materials) Specifications cited in this Specification or cited in reference documents shall be the year of adoption or tentative adoption and revision listed in the latest edition of the Annual Book of ASTM Standards Index, except that, should a specific year of adoption or revision be cited by the Contract Documents, by *Building Code*, or be proposed by Contractor and accepted by Structural Engineer, that edition shall apply to and control the Work.

E. Conformance to Regulations: Work of this Section shall conform to all applicable federal, state, and local laws and regulations.

1.5 SUBMITTALS

A. General: Submit samples, Shop Drawings, product data, test reports and data, manufacturer's names, certifications, procedures, methodology statements, and the like as stipulated. With the exception of samples, submittals shall be in PDF format and transmitted electronically, unless otherwise accepted.

1. Review of Contractor's submittals is only for the limited purpose of the examination of submittals for conformance with the design concept of the project and to assist Contractor in ascertaining that the information given in the submittals conforms to the requirements of the Contract Documents.
2. Review of Contractor's submittals is not conducted for the purpose of determining the accuracy or the completeness of the submittal, for dimensions or quantities, or for installation or performance of the system or the pieces(s) being submitted.

3. Submittals by Contractor implies that Contractor has checked the submittal with care. Where by error or other cause Contractor's check has not been accomplished, Contractor shall not rely on review, but shall first check and shall then resubmit such material as though the submittal had been rejected.

B. Samples: Submit for acceptance prior to purchase, fabrication or delivery:

1. One 2 foot (600 mm) long section of deck section.
2. Substitute Products, Materials and Fixtures, where requested by Contractor, shall be accompanied by sample(s) of an acceptable size.
3. Other Products, Materials and Fixtures, where requested in writing.

C. Shop Drawings:

1. General: Shop Drawings, as the term is used under this Section, are not Contract Documents, but are intended to demonstrate the way that Contractor intends to conform to the requirements provided in the Contract Documents. Contractor may wish to use these same drawings as a part of the instructions given to craftpersons for the accomplishment of the Work.
2. Best Standards: Shop Drawings furnished under this Section shall conform to the best standards of the construction industry. Shop Drawings shall be prepared by and under the supervision of competent engineering personnel. Prior to preparation, Contractor shall retain a Professional Engineer, accepted by Construction Manager and by Structural Engineer and registered in the State of this project, to supervise the preparation of and to check each Shop Drawing for compliance with the requirements of the Contract Documents.
a) Shop Drawings shall be prepared under the direction of personnel completely familiar with Architectural, Mechanical, Plumbing, Electrical and other building trades Drawings
3. Shop Drawings shall be submitted for review and to governing agencies having jurisdiction for acceptance in accordance with the provisions of the Contract Documents.
4. Shop Drawings shall be submitted for review as follows:
a) Job Standards
b) Erection Drawings
c) Field Work Drawings
5. Shop Drawings shall show clearly all metal deck Work, attachment welds and stud shear connectors. Work shall not be fabricated or delivered to the site before accepted Shop Drawings have been returned to Contractor. Detail in accord with and to accommodate Contractor's field measurements of supporting and adjoining construction.
6. Welds shall be detailed using symbols conforming to AWS A2.4,*Standard Symbols for Welding, Brazing, and Nondestructive Examination*.
7. Work of Other Sections: Show in Shop Drawings holes required for passage of Work of other Sections through metal deck Work. Provide Field Work Drawings for holes not shown in Erection Drawings.
8. Job Standards (i.e. Typical Detail Drawings) are intended to assist Contractor by developing the set of repetitive shop and field details.

9. Erection Drawings: Prepare complete Erection Drawings for metal deck and Stud Shear Connector Layout Drawings for field-applied stud shear connectors.

a) Erection Drawings shall show clearly the size and the location of each steel deck unit, accessories and their supports, all holes and openings including reinforcing for same, and field connection data, complete with all details necessary for assembling the steel deck system.

i) Performance Requirements: Contractor's Professional Engineer licensed in the project's jurisdiction shall design the metal deck system for the performance requirements of Part 2. As evidence of conformance with this requirement, each Erection Drawing shall bear the seal and signature of Contractor's Professional Engineer. Provide supporting calculations on request.

b) Contractor shall direct special attention to the possible need for special provisions and methods to resist safely all stresses caused by erection procedures and equipment, by construction loadings and by forces imposed by natural phenomena.

10. Field Work Drawings: Prepare Field Work Drawings depicting all field work required to accommodate field conditions.

11. Contractor shall coordinate and cross-check for accuracy, completeness and correct relationship to the work of other Sections, each Shop Drawing prepared for the Work of this Section, including each Shop Drawing prepared by accepted subcontractors. Contractor's check shall include a verification of compliance with the Contract Documents and shall be performed prior to submission and resubmission of each Shop Drawing. The personally inscribed initials of the person(s) preparing each shop drawing as well as the detailing agency's supervisor and chief checker shall be included in the title block or similarly prominent location.

12. Substitutions: Should Contractor desire a Substitution or Deviation from Drawings or Specifications, or both, Contractor shall submit the specific request in writing prior to the submittal of Shop Drawings showing the Substitutions or Deviations. Requests for Substitutions or Deviations shall be submitted on Contractor's letterhead. Substitutions and Deviations not identified, or identified only in letters of transmittal or in Shop Drawings, or both, without the required written description on Contractor's letterhead, may not be accepted and shall be sufficient cause for the rejection and the return of such Shop Drawings without further action.

a) Acceptance of Shop Drawings, including Substitutions and Deviations not detected during Shop Drawing review, shall not relieve Contractor from responsibility to conform strictly to the Contract Documents. Substitutions and deviations will be allowed only where permitted in writing.

b) Architect is the sole judge of the suitability of Contractor-proposed substitutions. Review of Contractor-proposed substitutions and deviations is subject to the compensation provisions of Article 1.12.

13. Shop Drawing Review: Only Shop Drawings marked "No Exceptions Taken" or "Make Corrections Noted - Resubmission Not Required" may be used by Contractor in the Work. Shop Drawings marked "Make Corrections Noted - Resubmit" shall be corrected or completed (or both) as required and shall be resubmitted. This process shall be repeated the number of times required to achieve the mark "No Exceptions Taken" or "Make Corrections Noted - Resubmission Not Required". An example of Structural Engineer's Shop Drawing review stamp is shown here for reference.

STRUCTURAL ENGINEER REVIEW

NO EXCEPTIONS TAKEN ☐ RESUBMISSION NOT REQUIRED ☐
MAKE CORRECTIONS NOTED ☐ RESUBMIT ☐
NOT REVIEWED ☐

LESLIE E. ROBERTSON ASSOCIATES

BY: _____

DATE: _____

a) Nonconformities and errors detected during review will be noted in Shop Drawings returned to Contractor upon completion of review. Acceptance of Shop Drawings, including Substitutions and Deviations not detected during review, will not relieve Contractor from sole responsibility to provide Work conforming strictly to the Contract Documents.
b) Shop Drawing review includes engineering calculations only to the extent deemed necessary to ascertain that Contractor's calculations have been prepared by competent personnel. Contractor alone is responsible for the accuracy and the completeness of Contractor's engineering calculations.
c) Should Architect's or Structural Engineer's marks or corrections be made in any Shop Drawing that would or could result in incorrect fit of any part or result in insufficient strength or stability of the Work, Contractor shall so notify in writing so as to expedite the required correction or modification.
d) Review of Contractor's Shop Drawings does not include a review of bills of material and the like. Accordingly, information required for the review of Shop Drawings shall be contained outside of bills of materials and the like.

14. Resubmission of Shop Drawings: Prior to resubmission of Shop Drawings with additions, deletions, or corrections, Contractor shall cloud and identify all changes from prior issues. Drawings submitted without each change both clouded and identified clearly will be returned and shall be resubmitted as though the original submittal had been rejected. Each submittal, whether or not accepted or rejected, shall contain a unique revision number, clearly identified

15. Shop Drawing Log: Contractor shall number Shop Drawings, and revisions to Shop Drawings, in a format acceptable both to Contractor and to Architect/Structural Engineer. Structural Engineer will provide to Contractor in its letters of transmittal both the log-in and the log-out date of each Shop Drawing. Further, on request of Contractor, Structural Engineer will provide to Contractor aged listings of each Shop Drawing remaining in the office of Structural Engineer.

D. Product Data: Submit printed manufacturer's literature for each manufactured item specified under Part 2 - Products - along with test data as may be requested. Include detailed instructions for application and installation.

E. Certifications:

1. Submit mill test certificates for metal deck and for stud shear connectors. Certificates shall include zinc or paint coating as applicable. Submit to governing agencies having jurisdiction. Comply with all applicable parts of *Building Code* and of ASTM Specification.
   a) Mill test reports shall state clearly the governing ASTM specification and shall be certified and notarized by Contractor as conforming in all respects to that specification.

2. Contractor shall certify that materials and systems delivered and installed in the Work are equivalent to assemblies tested under the Underwriter's Laboratories, Inc. listings of fire ratings and bear the Underwriter's Laboratories fire label.

3. Submit test reports, certified by an accepted independent laboratory, verifying the capability of metal deck units to act compositely with the concrete slab and to transfer safely horizontal shearing forces between metal deck and concrete slab when oiled or contaminated to a condition worse than that to be provided in the Work.

F. Assist Owner in preparation and submittal of roof installation and fire rating certifications as may be required to obtain insurance coverages.

G. As-Built Shop Drawings: In a format acceptable to each, and at the completion of the Work, provide to Owner, to Architect and to Structural Engineer, one complete digital set of all Shop Drawings (including Job Standards, Erection Drawings, Field Work Drawings and the like), so as to provide as-built drawings of finished and completed Work under this Section.

H. Governing Agencies: Provide all shop Drawings, tests, inspections, reports, affidavits, manufacturer’s certifications, certification of compliance with VOC limits, and other requirements and data to governing agencies having jurisdiction.

1.6 MEASUREMENTS AND TOLERANCES

A. Measurements:

1. Field Measurements: Obtain all field measurements required for proper fabrication and installation of Work covered by this Section. Submit, prior to installation, all measurements indicating discrepancies from the Drawings. Describe in writing and, where applicable, by sketches proposed methods of correcting discrepancies. Measurements are the responsibility of Contractor.

B. Tolerances: Provide metal deck Work, including flutings, screeds, closures and the like to tolerances not in excess of those permitted under Section 03 30 00, "Cast-in-Place Concrete". Contractor's attention is drawn specifically to tolerances at building perimeter, at elevator shafts, and at other penetrations through steel deck.

1.7 TESTING AND INSPECTION

A. Owner's Testing Agency: All work is subject to Special Inspection as required by *Building Code*. Subject to acceptance by Architect, Owner will engage and pay for the services of an independent testing agency (Testing Agency) as outlined in Section01 40 00, Inspection and Testing. Contractor alone is responsible for the achieving of the required level of quality, both in the shop and in the field. Testing Agency will rely heavily on reviewed Shop Drawings, as described earlier in this Specification, in its examination of as-constructed Work. The selected Testing Agency will meet the requirements of ASTM E329. Contractor shall not retain Owner's Testing Agency for its own work but may, subject to acceptance by Owner, contract through Owner for such work.

1. On instructions and at locations selected by Architect, Testing Agency may sample materials taken from the as-erected Work.

B. Authorizations: Owner's Testing Agency will not be authorized to:

1. Authorize or accept deviations or substitutions from the Contract Documents.
2. Assume any of the responsibilities of Contractor; for example, Testing Agency may not advise formally or informally on any aspect of construction means, methods, techniques, sequences or procedures, or safety precautions and programs in connection with the Work.
3. Accept Shop Drawings or samples.
4. Approve or issue a Certificate of Payment, a Change Order, or issue verbal instructions which modify the Contract between Owner and Contractor.

C. Responsibilities and Duties of Contractor:

1. Performance or waiving of inspection, testing or surveillance by Testing Agency for a given portion of the Work will not relieve Contractor from responsibility to conform strictly to the requirements of the Contract Documents.

2. Access to Documents, Facilities and Materials: Furnish one copy of each accepted Shop Drawing and of each mill test certificate to Testing Agency. Provide reasonable office, desk and file space at the site to allow Testing Agency to conveniently work with and to maintain project records and drawings. Provide authorized personnel convenient and free access to all parts, locations and areas of Work, including storage areas. Provide hoisting, turning and moving of materials and reasonable quantities of scaffolding, power, casual labor, and other provisions and assistance necessary to allow quality and effective inspection and testing of Work.

3. Notice: Provide reasonable notice of the initiation of Work to facilitate and to assist testing and inspection.

4. Cost of Owner's Tests by Testing Agency will be borne by Owner. However, where additional tests are deemed necessary on account of failure to pass tests, the cost of additional testing will be deducted from payments to Contractor so as to reduce the Contract price.

1.8 QUALITY ASSURANCE

A. Source Quality Control: Contractor's material control procedures shall be effective and shall assure that all Work fulfills the requirements of the project as well as the applicable provisions of the Contract Documents. All structural steel shall be identified and all material shall be tested in accord with the requirements of *Building Code*, of Building Department, of governmental authorities having jurisdiction and of this Specification.

B. Construction Site Quality Control: Contractor shall maintain, on staff, sufficient office, field engineering, and field supervision staff to assure that all data and layout drawings for Work of other Sections is transmitted to detailers to allow proper detailing of holes, penetrations, chases, and the like and to assure proper execution of the Work in the field.

C. Qualifications:

1. The Contractor performing the Work of this Section must, within the last five (5) consecutive years, have successfully completed in a timely fashion at least two (2) projects similar in scope and type to the required work for this Section.

2. Contractor shall determine, shall warrant and shall certify that producers, detailer, fabricator, erector, placer and all others involved in the Work, along with their personnel, are experienced, qualified and adequately staffed to undertake the specific Work required under this Section.

D. Steel Deck Erector: The Erector performing the Work of this Section must, within the last five (5) consecutive years, have successfully completed in a timely fashion at least three (3) projects similar in scope and type to the required work for this Section.

E. Welder Qualification: Welders and welding operators performing Work under this Section shall be qualified in accordance with the *Building Code* and with applicable AWS requirements for each specific welding procedure and process which the welder will use in the Work.

F. Documentation of Contract Conformance: Perform quality control functions required to achieve and to document that Work conforms to the Contract Documents. Provide access to Contractor's quality control documents and reports upon request. Provide reasonable numbers of copies of specific quality control reports on request.

1.9 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Storage of Materials:

1. Deck items stored on or off the project site shall be supported above ground on platforms, skids or other supports. Where applicable, stacked members shall be separated by effective softeners. Storage methods shall protect deck units from overstress, permanent deformation and other damage.

2. Deck shall be protected from corrosion. Storage methods shall provide for free and rapid drainage of rainwater and prevent collection of water on or within stored members.

3. Related Materials shall be delivered to the site, ready for use, in the manufacturer's original and unopened containers and packaging, bearing labels as to type of material, brand name, and manufacturer's name. Delivered materials shall be identical to accepted samples.

4. Storage of steel deck bundles, materials, tools and erection aids on the structure shall be performed in manners preventing distortion, damage and overstress of the supporting Work. Damaged members, materials or structural systems shall be replaced or repaired as directed.

B. Identification: Provide and maintain identification in accordance with the AISI Specification and the Steel Deck Institute Specification. Provide ASTM Specification, yield point, and grade, by painting or decal, on each bundle of fabricated elements.

1. On completion of the Work, Contractor shall submit an affidavit, countersigned by the appropriate subcontractor(s), attesting that all materials and products provided for the Work conform to the applicable specifications, standards, yield points, grades and the like required by the Contract Documents.

C. Handling of Steel Deck: Bundling, stacking and hoisting means shall be capable of placing steel deck units in the Work, free from permanent distortion due to bending of deck edges or buckling of sections.

D. Removal: Delivered materials which are damaged or otherwise not suitable for installation, shall be removed from the job site and replaced with acceptable materials.

1. Construction Manager and Architect shall be the sole judge of the suitability of such materials and neither Owner nor Contractor may challenge Construction Manager's or Architect's decisions as to acceptability.

1.10 JOB CONDITIONS

A. Contractor's Responsibility: Contractor shall be solely responsible for the correctness of dimensions and quantities and for the fitting to other Work; for Work to be confirmed and correlated at the site; for information pertaining to the fabrication procedure or to the means, methods, techniques, sequences and procedures of construction; and for the coordination of the Work of this Section with the Work of all other trades. The verification of the physical interrelationships of elements of the Work from Contract Documents and in the field is solely Contractor's responsibility. Review of Contractor's submissions does not relieve Contractor from these responsibilities.

B. Contractor's Coordination: Contractor shall coordinate and schedule the Work of this Section with the Work of other Sections of this Specification in order to optimize quality and to avoid delay in overall job progress.

C. Rejection of Work: Testing Agency may inspect and test materials at the source before shipment as well as at the site before, during or after installation in the Work. Construction Manager and Architect reserve the right, at any time before final acceptance of the completed Work, to reject material not conforming with specified requirements, regardless of previous tests, inspections, acceptances, or inclusion in certificates of payment.

D. Provisions for Other Work: The Work under this Section shall include required cutting, punching, drilling, welding, reinforcing and all else required for the attachment and the passing-through of other Work.

E. Construction Sequence: Descriptions of limitations on construction sequence are intended to assist Contractor in coordinating the Work of the Project. Descriptions do not describe fully the limitations given, do not describe all limitations, nor do they preclude construction sequences not contemplated herein. Whether or not Contractor follows the limitations on construction sequence described herein, Contractor remains fully responsible for both the stability and the safety of the Work; adherence to the limitations described herein does not relieve Contractor from that responsibility.

1. Generally, the structure is to be constructed from the bottom to the top, floor-by-floor, with Contractor supplying such temporary bracing and shoring as may be required to compensate for the lack of completion of portions of the construction.
2. Steel deck Work is essential to the overall stability of the building frame.
3. Sealing of Shop Drawings by Contractor's Professional Engineer shall include and imply a full review of construction sequence and of related operations.

F. Construction Loads: The structure is designed to resist safely the loading prescribed by *Building Code* for the finished building. No provision is included for loads or stresses imposed or induced by Contractor's means and methods of construction. Design loads are provided in *Building Code* but are sometimes modified upward as provided in Structural Engineer's Design Criteria.

1. Where Contractor elects to place loads on the structure or elects to otherwise load or deform the structure in excess of the design loads, Contractor shall submit drawings and supporting calculations prepared under the supervision of and sealed by Contractor's Professional Engineer.
   a) Review of Contractor's submittal shall not relieve Contractor from full responsibility for Contractor's means and methods of construction.
   b) Review of Contractor's submittal will be treated as a Substitution or Deviation, as provided under Article 1.14.

2. Alternatively, Contractor may seek professional services from Structural Engineer. Such services may be obtained through Owner or, with the permission of Owner, may be obtained directly from Structural Engineer. Architect will not be involved contractually in any such services.

G. Accidents and Hazardous Conditions: Contractor shall prepare a detailed written report of all accidents and other occurrences involving death, personal injury and/or significant losses in tangible property and shall submit the report promptly.

H. Installing and Rigging Equipment: Contractor shall shore all construction susceptible to impact loading from the installation of equipment installed by other trades.

1. Such equipment shall include but shall not be limited to boilers, chillers, refrigeration equipment, transformers, elevator machines and the like.

2. Remove shoring when equipment installation is complete.

1.11 DEFICIENT WORK

A. Repairing, Patching, Cleaning: Contractor shall correct all deficiencies in the Work of this Specification, including areas where Testing Agency reports or Construction Manager’s or Architect’s rejections have indicated that Work is not in full compliance with the Contract Documents. Perform, at no expense to the Owner, all additional tests which Construction Manager or Architect deems necessary to reconfirm noncompliance of the original Work and perform, at no expense to Owner, all tests and inspections which may be necessary to show compliance of corrected Work.

B. Defective and Nonconforming Work: Defective Work, unsuitable Work or Work otherwise failing to conform to the Contract Documents shall be made good by Contractor at no change in the amount of the Contract. Contractor shall prepare appropriate details and procedures for bringing such Work into conformance with the Contract Documents and shall submit such details and procedures for acceptance. Corrective Work, including materials, shall conform strictly to accepted details and procedures. Nonconforming Work may be rejected at any time, regardless of prior acceptance in Shop Drawings, prior inspection, inclusion in inspection or test reports, or inclusion in certificates of payment.

C. Deficiencies: Where Work exhibits any one or more of the following deficiencies, or where Work otherwise fails to conform to the requirements of the Contract Documents and to the requirements of Building Code, for any reason or combination of reasons, such Work shall be considered deficient and not in conformance with the requirements of the Contract:

1. Bent, twisted, buckled or warped pieces.
2. Unauthorized cutting, and so forth.
3. Exceedance of tolerances.
4. Painted, unpainted or galvanized surfaces not sufficiently clean to receive spray fireproofing or paint.
5. Metal deck surfaces not sufficiently clean to receive field-applied deck welding.
6. Workmanship not in accord with the Drawings, with these Specifications, with accepted samples, or with referenced codes or standards.

D. Replacement or Repair: Where Construction Manager or Architect, at its sole discretion, finds any of the above deficiencies or other Work not in accord with the Contract Documents, Construction Manager or Architect may order that the affected Work be replaced or repaired at Contractor's expense.

1. Contractor shall reimburse Owner for the actual amount of the fees of Testing Agency for the reinspection and the retesting of Work deemed defective by Construction Manager or by Architect.

E. Cost: The cost of all other activities and procedures associated with defective Work shall be paid by Contractor.

1.12 PART-TIME PARTICIPATION - SURVEILLANCE ENGINEER

A. Surveillance Engineer: From time-to-time Structural Engineer may provide at the construction site, the services of a Surveillance Engineer taken from its New York office. Principal responsibilities of Surveillance Engineer will be as follows:

1. Endeavor to provide further assurance that structural Work is accomplished in accordance with the requirements of the Contract Documents.
2. Assist in the expeditious removal of obstacles to the progress of the Work.

B. Structural Engineer's Surveillance Engineer will not be authorized to:

1. Personally conduct or direct the performance of tests, but will witness and will advise on such tests where appropriate.
2. Authorize deviations from the Contract Documents without prior written consent of both Owner and Architect.
3. Assume any of the responsibilities of Contractor; for example, Surveillance Engineer may not advise formally or informally on any aspect of construction means, methods, techniques, sequences or procedures, of safety precautions and programs in connection with the Work.
4. Accept Shop Drawings or samples without special permission from Structural Engineer's office in New York.
5. Approve or issue a Certificate of Payment, a Change Order, or issue verbal instructions which modify the Contract between Owner and Contractor.

C. Activities of Surveillance Engineer: The activities of the Surveillance Engineer do not constitute either inspection or acceptance of the Work, nor shall they be construed to relieve Contractor from full responsibility for the means and methods of construction or for safety on the construction site.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General: Contractor shall be solely responsible for the design, engineering and adequacy of all metal deck, its connection and accessories.

B. Metal Deck and Accessories Design: Metal deck and accessories shall be designed by Contractor's Professional Engineer licensed in the project jurisdiction.

C. Deck Connections: Metal deck fastening to steel and side laps shall be designed by Contractor's Professional Engineer licensed in the project jurisdiction. Acceptable fastening methods include fusion welds, powder actuated fasteners and screws. Connection design shall be sufficient to maintain building alignment and to sustain construction loads without distortion or separation.

D. Section Properties for Metal Deck Units shall be based on the design provisions of the *AISI Specification* and with the assumption that the deck is fabricated from FY50 ksi material.

1. Provide not less than the deck section properties shown or scheduled in Drawings or given in this Specification.
2. Provide section properties as needed to meet criteria given in Drawings and in this Specification and as needed to meet best quality standards.

E. Thickness: The minimum thickness of steel deck before coating with paint or metal shall not be less than 95% of the design thickness as per the Steel Deck Institute Design Manual. Thickness tolerances such as given in Table 2 of ASTM A924 are not acceptable. Submit reports of all metal deck thicknesses for acceptance prior to fabrication.

F. Flashing and Screeds shall be not thinner than 18 gauge (1.2 mm) and shall be adequately stiff and strong to meet all imposed loads and criteria.

G. Floor Diaphragm: Provide steel deck floor diaphragm sufficiently stiff and strong so as to adequately brace structural steel Work.

1. Where given in Drawings, provide stipulated diaphragm shear strength; do not increase allowable stresses in achieving the required diaphragm shear strength; provide a factor of safety of not less than 3.0 for welds and/or mechanical fasteners required to achieve and/or to transfer diaphragm shears.

2.2 MATERIALS

A. Steel Deck:

1. Metal deck shall be fabricated from steel conforming to Section A3 of the AISI Specification.

2. Steel for galvanized finish: ASTM A653, Structural Steel (SS) grade 50, not thinner than 20 gauge (0.9 mm). Provide a minimum yield point of 50 ksi (340 MPa).

3. Galvanizing shall conform to ASTM A924 with a minimum coating class of G90 (Z275) or heavier. All metal deck shall be galvanized, unless otherwise noted.

4. Roof Deck. Provide deck 20 gauge (0.9 mm) or thicker. Whether or not listed below, provide metal deck units which have been evaluated by Factory Mutual System and are listed in *Factory Mutual Approval Guide* for Class 1 fire-rated construction. Provide panels, without top flange stiffening grooves, to comply with SDI Specifications and Commentary for Steel Roof Deck, SDI Publication No. 30. Acceptable manufacturers and profiles (not concrete covered) are:

a) ASC Steel Deck
   i) B-36, 1 1/2" (40 mm)

b) Consolidated Systems, Inc.
   i) Type B, 1 1/2" (40 mm)

c) Roof Deck, Inc.
   i) Type B (WR), 1 1/2" (40 mm)

d) United Steel Deck, Inc., by Canam Group, Inc.
   i) Type B, 1 1/2" (40 mm)

e) Vulcraft Division of Nucor Corp.
   i) Type 1.5B, 1 1/2" (40 mm)

f) Equivalent systems will be considered. Refer elsewhere in this Specification for Contractor's obligations with respect to fees of Architect and of Structural Engineer associated with the review of Contractor-proposed alternates and deviations.

g) Where membrane waterproofing or roofing is to be applied/adhered directly to the surface of the overlying concrete, the deck shall be ventilated to allow for the escape of moisture. This deck shall have the same load-carrying capacity as non-ventilated deck and shall be certified by the deck manufacturer and approved by the membrane manufacturer for compliance with the guarantee requirements of the membrane manufacturer.

B. Sheet Metal Accessories: Pour stops, column closures, cover plates and the like shall be the type required by the Steel Deck Institute and shall conform to ASTM A924 with a minimum coating class of G60 (Z180) as specified in ASTM A653. Provide materials with a yield point of 50 ksi.

C. Galvanizing Repair Paint: Provide organic, zinc-rich paint that contains at least 90% zinc particles in the dried film for the repair of damaged galvanized surfaces. Galvanized paint shall comply with either ASTM A-780, Federal Specification DOD-P-21035 or Military Specification MIL-P-26915.

1. Brite Zinc, by Brite Products
2. ZIRP, by Duncan Galvanizing Corp.
3. ZRC Cold Galvanizing Compound, by ZRC Products Co.
4. Other where accepted

D. Miscellaneous Steel Shapes and Plates: ASTM A572 grade 50 or as otherwise chosen from steels listed in the AISC Specification.

E. Welding Materials shall conform to *Building Code* and to AWS A5.1 and shall be E7018 (E48018) or E6011 (E41011) for joining steel deck to structural steel and for welding steel deck edge laps; E7018 (E48018) for joining steel shapes and plates.

F. Weld Washers: Weld washers are to be used in containing the arc spot welds in sheet steel thinner than 0.028 inches (0.7 mm) or where required to prevent burn back.

1. Thickness shall be not less than 0.056 inches (1.5 mm), 16 gage and nominal diameter hole shall be 3/8 inch (10 mm).
2. Uncoated material may be used.

G. Self-Drilling Fasteners for Deck Edge Laps: (1) S-SLC 02 M HWH side lap connector screw as manufactured by Hilti Inc, or (2)#12-14 x 3/4" HWH TEKS/1 as manufactured by ITW Buildex Loadmaster Systems, Inc. or other accepted self-drilling fastener.

H. Powder Actuated Fasteners for Deck to Steel Connection: X-HSN-24 or X-ENP-19 powder actuated fastener by Hilti Inc or other accepted powder actuated fastener.

I. Lip Hangers shall be not less than 18 gauge (1.2 mm) galvanized, not less than 2 inch (50 mm) wide, with 3/8 inch (10 mm) diameter hole, shall extend 3 inch (75 mm) below the bottom of the deck, and shall be U.L. approved.

PART 3 - EXECUTION

3.1 CONTRACTOR'S INSPECTION

A. Examination of Field Conditions: Examine all surfaces, features and facilities to which Work must be attached or applied, abut or clear. Notify Construction Manager and Architect in writing of all conditions which are or will be detrimental to proper and expeditious installation of Work. Starting of Work shall represent acceptance by Contractor of surfaces and of conditions as suitable and correct for performing Work as specified.

B. Field Measurements: Contractor shall verify, by measurements at the job site, all dimensions affecting the Work of this Section. Field dimensions at variance with those in accepted Shop Drawings shall be reported in writing by Contractor. Decisions regarding corrective measures shall be subject to acceptance and acceptance shall be obtained before starting fabrication of items affected. The starting of Work shall represent acceptance by Contractor of all dimensions affecting the Work of this Section as suitable and correct for the performing of all Work under this Section.

3.2 NOT USED

3.3 FABRICATION

A. General: Form steel deck unit in lengths to provide 3-span condition where practical. One, two and four span conditions shall be avoided except where openings, building configuration and the like do not allow 3-span condition. Provide flush abutting ends and rigidly connected side laps, unless otherwise indicated. Provide not less than two inches (50 mm) of end bearing on supports. Where provided in Drawings, stagger end laps so as to avoid continuous joints through the deck Work.

B. Weld Size and Spacing joining the bottom flat sheet to the fluted top sheet of cellular sections shall fully develop the section properties of the combined sheets. The design strength per weld shall comply with the requirements of the *AISI Specification*. Weld quality shall conform to UL 209, AWS D1.1, AWS D1.3 and *Building Code*.

C. Side Laps: Take care that side laps can be properly accomplished in the field, noting particularly:

1. improper height of the male leg of the side joint, where fastened by welding, button punching or by self-drilling fasteners; and
2. any other deficiency in the side joint configuration.

D. Sump Pans: Fabricate from a single piece of not less than 14 gauge (1.9 mm) galvanized sheet steel of the same quality as the deck units. Provide sump pans with sloping bottoms and sloping or vertical sides to direct water flow to the drain, unless otherwise shown. Provide sump pans of adequate size to receive drains and with bearing flanges not less than 3 inches (75 mm) wide. Recess pans not less than 1-1/2 inches (40 mm) below the deck surface, unless otherwise shown or required by deck configuration. Holes for drains may be cut in the field or as otherwise provided in Shop Drawings. Reinforce steel deck surrounding openings prior to cutting deck to provide opening.

E. Factory Cut: To the extent practical, factory cut elements to length.

3.4 ERECTION

A. Install steel deck units and accessories in accord with manufacturer's recommendations, accepted Shop Drawings, and as specified herein.

B. Coordinate and Cooperate with structural steel erection Work and in locating decking bundles to prevent overloading of structure.

C. Cleaning: Prior to laying out steel deck units, Contractor shall clean surface of supporting steel, removing grease, oil, debris and other deleterious foreign material which may interfere with the consistent achievement of sound welding arc welding of deck units to supports.

D. Bearing: Place steel deck units with 2 inch (50 mm) minimum end bearing and 1-1/4 inch (35 mm) minimum side bearing on supporting framework. Adjust to final position and accurate alignment, end-to-end and edge-to-edge, prior to making permanent attachment. Do not stretch or contract sections or side-lap interlocks. Each unit shall be free from excessive deflection, local distortions and damage when aligned and permanently joined into the structure.

E. Cut and Fit Deck Units and accessories around other Work projecting through or adjacent to the decking, as found in the field and as given in Drawings. Provide neat, square and trim cuts. Provide miscellaneous structural supports at locations where specific support details are not given in the Drawings.

F. Temporary Use: Do not use deck units for storage or working platforms until permanently secured.

G. Preparation: Prior to beginning welding, each steel deck unit shall be brought into intimate contact with steel supporting members and shall be maintained in contact throughout the duration of welding. Prior to stud welding, embossments shall be flattened to the extent necessary to provide uniform contact between the metal of the steel deck unit and the face of the supporting steel member to which the stud is to be fused. Moisture between supporting steel and steel deck units shall be removed immediately prior to welding.

H. Fastening: Permanently fasten steel deck units to supporting member by minimum 3/4 inch (20 mm) diameter arc spot welds or powder actuated fasteners. Welds shall be spaced at 12 inches (300 mm) maximum unless a smaller spacing is given in the Drawings or otherwise required by the provisions of this Specification. Powder actuated fastener size and spacing shall be such that it has the equivalent strength of spot welds. The minimum fastening requirements are as follows:

1. Weld each valley of each unit to each supporting member by minimum 3/4 inch (20 mm) diameter arc spot weld.
2. Weld deck edges and interior ribs to parallel supporting members by minimum 3/4 inch (20 mm) diameter arc spot welds at 12 inches (300 mm) maximum spacing except where a smaller spacing is given in the Drawings or required by this Specification.
3. Elongated welds, both accepted by Structural Engineer and providing strength equal to or greater than 3/4 inch (20 mm) round arc spot welds, may be used.
4. Welds shall be fused thoroughly to the steel deck around the weld perimeter or circumference as well as to the supporting steel member.

I. Use Weld Washers where recommended by deck manufacturer, at all locations where metal thickness is equal to or less than 0.0280 inches (0.7 mm), and at all locations where required to achieve consistently sound are spot welds.

J. Wind Uplift: Steel deck units (with special emphasis upon roof units and deck units with sump pans) shall be secured to the structural steel to the extent necessary to resist, without overstress, maximum wind uplift forces. Such forces shall be determined from data contained in the Drawings, *Building Code* and or in ASCE 7, whichever is larger.

K. Side Laps: Metal deck side laps shall be permanently fastened by either fusion welds or metal screws. The minimum fastening requirements are as follows:

1. Lock side laps between adjacent deck units by welding at intervals not exceeding 36 inches (900 mm) or by self-drilling screws at intervals not exceeding 36 inches (450 mm).
2. At cantilever spans, side lap locks shall be placed not more than 3 inches (75 mm) from deck end and at intervals not exceeding one-half of normal spacing.

L. Comply with AWS D1.3 for welding of steel deck including provisions regarding appearances, quality of welding and corrective methods. Use certified welders throughout.

M. Punched Slots at Slabs Receiving Waterproof Membrane: Provide punched slots between flutes in all steel deck forming slabs which will receive waterproof membrane treatment. Hanger-tab slots along each rib at 12 inches (300 mm) on center, that have been bent down in the field, are satisfactory for this purpose.

N. Reinforcement at and Cutting of Openings: All proposed openings shall be submitted for review prior to construction. Reinforcement of openings in metal deck shall be designed by Contractor's Engineer except in cases where LERA has specified bottom rebar or specifically designed the metal deck. Provide additional metal reinforcement and closure pieces as required for strength, continuity of decking and support of other Work. At a minimum, reinforce decking around openings in accordance with details and notes given in the Contract Documents and in accepted Shop Drawings.

1. Unframed openings larger than 6 inches (150 mm), and all cases where deck strength is impaired, shall be reinforced to the extent required, but not less than:
a) Holes 6 inches (150 mm) to 12 inches (300 mm): provide 16 gauge (1.5 mm) or thicker flat sheet, extending at least 6 inches (150 mm) beyond hole on all sides.
b) Holes 12 inches (300 mm) to 18 inches (450 mm): provide 2 x 2 x 3/16 (45 x 45 x 5 mm) or thicker angle, extending at least 16 inches (400 mm) beyond hole in both directions.
c) Weld all of needed reinforcing to top side of unfilled/roof deck and bottom side of composite deck.

O. Roof Sump Pans: Place roof sump pans over openings in the roof decking and weld or fasten to the top decking surface. Space welds or fasteners not more than 12 inches (300 mm) center-to-center with at least one weld at each corner. Cut openings in the bottom of the roof sump to accommodate the drain size indicated. Proportion roof sump pans and their connections as applicable to resist maximum wind uplift pressures.

P. Building Interior and Exterior Perimeter Edge Conditions: Fabricate gauge thickness sheet steel edge angles, bent plate angles and rolled steel angles. Provide material of not thinner than 12 gauge (2.6 mm), with a 45° continuous, 1 inch (25 mm) deep hook with adequate shop fabricated and shop attached stiffeners. Fabricate edge condition members to accommodate facade support system members and fittings. Provide and weld in place, all gauge thickness edge angles, bent plate angles, miscellaneous support angles, corrugated sheet steel, sheet steel closures and all else needed to conform to details and notes given in the Drawings and in accepted Shop Drawings. Edge conditions installation shall be true to line and elevation and ready to receive facade support system.

Q. Joint Covers: Provide metal or tape joint covers at abutting ends of deck units. Tape and seal all joints in accordance with or better than the standard accepted details of the manufacturer of the steel deck units.

R. Stools or Shims: Provide stools or shims where support does not meet bottom of deck.

S. Touch-Up Painting: After decking installation is complete, wire brush, clean and paint scarred areas, welds and rust spots on the top and bottom surfaces of decking units and supporting steel members. Touch-up galvanized surfaces with galvanizing repair paint, applied in strict accord with manufacturer's printed instructions.

T. Clean Surfaces: Leave all steel deck surfaces free and clean.

U. Lip Hangers: Locate at all deck side laps, spaced not more than 14" o.c. (350 mm), but not more than 4" (100 mm) from the edge of beam flanges and from non-continuous ends of deck.

V. Completion: The steel deck system installation, upon completion, shall be neat in appearance and suitable to receive concrete without leakage between sections or through end and edge closures.

END OF SECTION 05 30 00

SECTION 21 00 01 – FIRE PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Related Documents identified in Division 00 Bidding and Contract Requirements and Division 01 General Requirements.

1.1 SUMMARY

A. Work Included: Provide labor, materials, and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Wet sprinkler system.
2. Dry Sprinkler system
3. Gate valves, check valves, and drain valves.
4. Sprinkler heads, piping, fittings and valves.
5. Preparation of complete "Fire Protection Working Shop Drawings" and calculations.
6. Tests of all piping, systems, devices and alarms.
7. Sleeves, escutcheons, hangers and supports.
8. Flow tests.
9. Fire Department connection.
10. Pressure gauges.
11. Miscellaneous steel supports.
12. Flow and tamper switches.
13. Sprinkler drains.
14. Backflow preventer on fire water service.
15. Identification of systems, equipment and valves.
16. Shop drawings and submittals.
17. Permits, fees and inspections.
18. System and equipment start-ups; instructions.
19. Operation and Maintenance Manuals.
20. Flexible connectors, expansion fittings.
21. Drilling for installation of inserts.
22. Thrust blocks and related supports and restraints.
23. All cutting, core drilling and channeling for fire protection equipment.
24. Coordination drawings and record drawings and similar requirements.
25. Hoisting Equipment: The Fire Protection subcontractor shall furnish, install and maintain in safe and adequate condition all mechanical hoisting equipment, operating personnel and rigging that is necessary for the proper execution of the Work of this Section.
26. Staging, Planking, and Scaffolding: The Fire Protection subcontractor shall furnish, install and maintain in safe and adequate conditions, all staging, planking and scaffolding that is necessary for the proper execution of the

Work in this Section.

27. Fire stopping and smoke stopping of penetrations made by Fire Protection sub-contractor
28. The Commissioning process requires the participation of Division 21 00 01, Fire Protection, to ensure that all systems fulfill the functional and pre-functional requirements outlined in these construction documents. The general commissioning requirements and coordination are detailed in Section 01 91 13 General Commissioning Requirements. Fire Protection, shall fulfill commissioning responsibilities assigned to Section 21 00 01 per Section 01 91 13- General Commissioning Requirements.

B. The following related section includes work to be incorporated in the Fire Protection Filed Sub Bid:

1. Division 01 Section “Temporary Facilities and Controls” for temporary lifts and hoists, and staging and scaffolding furnished and installed by the Fire Protection Trade Subcontractor.
2. Division 01 Section “Cutting and Patching” for cutting and patching requirements for openings equal to or less than 12 inches in all partitions in conjunction with the work of the Fire Protection Filed Sub Bid.
3. Division 01 Section “General Commissioning Requirements.”
4. Division 01 Section “Exterior Enclosure Commissioning Requirements.”
5. Division 07 Section “Penetration Firestopping” for penetration firestopping furnished and installed by the Fire Protection Trade Subcontractor.
6. Division 08 Section “Access Doors and Frames” for access panels furnished by the Fire Protection Trade Subcontractor for installation by the General Trades Subcontractor.

C. The Work of this Section is shown on the following Drawings: FP001, FP201 and FP601.

The Trade Contractor shall also review all other Drawings and all other Sections of the Specifications for coordination requirements therein affecting the Work of this Section, not just those pertaining to this Sub-trade.

D. Items to Be Furnished Only: Furnish the following items for installation by the designated Sections:

a. Section 08 31 13 ACCESS DOORS AND FRAMES for access doors to be furnished for installation by General Trades Subcontractor.

b. Section 03 00 00 Cast in Place Concrete
   1. Sleeves, Lintels, anchors, inserts, plates and similar items for the fire protection system

c. Section 04 20 00 Masonry
   1. Access doors, sleeves and recessed cabinets for valves

d. Section 09 06 00 Gypsum Board Assembles
   1. Sleeves, Access Doors in gypsum board assemblies

E. Following items are not included in this Section and will be performed under the designated Sections.

1. Division 23 Sections for coordination with HVAC piping and ductwork.
2. Division 28 Sections for fire alarm devices.
3. Division 31 Earthwork and Backfill fire lines outside the building.

F. Perform work and provide material and equipment as shown on Drawings and as specified or indicated in this Section of the Specifications. Completely coordinate the work of this Section with work of other trades and provide a complete and fully functional installation.

G. Drawings and Specifications form complementary requirements; provide work specified and not shown, and work shown and not specified as though explicitly required by both. Although work is not specifically shown or specified, provide supplementary or miscellaneous items, appurtenances, devices and materials obviously necessary for a sound, secure and complete installation.

H. Give notices, file plans, obtain permits and licenses, pay fees and back charges, and obtain necessary approvals from authorities that have jurisdiction to perform work in accordance with all legal requirements and with Specifications, Drawings, Addenda and Change Orders, all of which are part of Contract Documents.

1.6 DEFINITIONS

A. As used in this Section, "provide" means "furnish and install" and "POS" means "Provided Under Other Sections". "Furnish" means "to purchase and deliver to the project site complete with every necessary appurtenance and support," and "Install" means "to unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project."

1.7 SUBMITTALS

A. Comply with requirements specified in Section 01 33 00 – SUBMITTAL PROCEDURES.

B. Material and equipment requiring Shop Drawing Submittals shall include but not be limited to:

1. Fire Protection Products:
   a. Sprinkler alarm valves.
   b. Fire Department connections.
   c. Sprinkler heads.
   d. Valves.
   e. Pipe and fittings.
   f. Electric bell.
   g. Fire department valves.
   h. Hangers and supports.
   i. Alarm devices.
   j. Back Flow Preventer
   k. Sleeves
   l. Access panels
   m. Expansion loop

1.8 MODIFICATIONS IN LAYOUT

A Fire Protection Drawings are diagrammatic. They indicate general arrangements of mechanical and electrical systems and other work. They do not show all offsets required for coordination nor do they show the exact routings and locations needed to coordinate with structure and other trades and to meet Architectural requirements.

B In all spaces, prior to installation of visible material and equipment, including access panels, review Architectural Reflected Drawings for exact locations and where not definitely indicated, request information from Designer.

C Check Contract Drawings as well as Shop Drawings of all subcontractors to verify and coordinate spaces in which the work of this Section will be installed.

D Maintain maximum headroom at all locations. All piping and associated components to be as tight to the underside of structure as possible.

E Make reasonable modifications in layout and components needed to prevent conflict with the work of other trades and to coordinate according to Paragraphs A, B, C, D above. Systems shall be run in a rectilinear fashion.

F Where conflicts or potential conflicts exist and engineering guidance is desired, submit sketch of proposed resolution to Designer for review and approval.

1.9 SITE VISIT

A Before submitting bid, visit and carefully examine site to identify existing conditions and difficulties that will affect the work of this Section. No extra payment will be allowed for additional work caused by unfamiliarity with site conditions that are visible or readily construed by experienced observer.

1.10 EXISTING CONDITIONS AND PREPARATORY WORK

A Before starting work in a particular area of the project, visit site and examine conditions under which work must be performed including preparatory work done under other Sections or Contracts or by the User Agency. Report conditions that might affect work adversely in writing through General Contractor to Designer. Do not proceed with work until defects have been corrected and conditions are satisfactory. Commencement of work shall be construed as complete acceptance of existing conditions and preparatory work.

1.11 CODES, STANDARDS, AUTHORITIES AND PERMITS

A Perform work strictly by rules, regulations, standards, codes, ordinances, and laws of local, state, and Federal governments, and other authorities that have legal jurisdiction over the site. Materials and equipment shall be manufactured, installed and tested as specified in latest editions of applicable publications, standards, rulings and determinations of:

1 Local and state building, plumbing, mechanical, electrical, fire and health department codes.
1. National Fire Protection Association (NFPA 2019 edition).
2. American Insurance Association (A.I.A.) (formerly National Board of Fire Underwriters).
3. Occupational Safety and Health Act (OSHA).
4. Factory Mutual Association (FM).
5. Underwriters' Laboratories (UL).
6. American National Standards Institute (ANSI).

B. Material and equipment shall be listed by Underwriters' Laboratories (UL), and approved by ASME for intended service.

C. When requirements cited in this Specification conflict with each other or with Contract Documents, most stringent shall govern work. Designer may relax this requirement when such relaxation does not violate ruling of authorities that have jurisdiction. Approval for such relaxation shall be obtained in writing.

D. Most recent editions of applicable specifications and publications of the following organizations form part of Contract Documents:

1. American National Standards Institute (ANSI).
2. American Society of Mechanical Engineers (ASME).
3. National Electric Manufacturers Association (NEMA).
4. American Society for Testing and Materials (ASTM).
5. American Water Works Association (AWWA).
6. Institute of Electrical and Electronics Engineers (IEEE).
7. Insulated Cable Engineers Association (ICEA).
8. National Fire Protection Association (NFPA).

1.12 GUARANTEE AND 24 HOUR SERVICE

A Guarantee Work of this Section in writing for one year following the date of beneficial occupancy by the User Agency. The guarantee shall repair or replace defective materials, equipment, workmanship and installation that develop within this period, promptly and correct damage caused in making necessary repairs and replacements under guarantee within Contract Price.

B In addition to guarantee requirements of Division 01 and of Subparagraph A above, obtain written equipment and material warranties offered in manufacturer's published data without exclusion or limitation, in User Agency's name.

C Replace material and equipment that require excessive service during guarantee period as defined and as directed by Designer.

D Provide 24 hour service beginning on the date the project is first beneficially occupied by the User Agency, whether or not fully occupied, and lasting until the termination of the guarantee period. Service shall be at no cost to the User Agency. Service can be provided by this contractor or a separate service organization.

Choice of service organization shall be subject to Designer and User Agency approval. Submit name and a phone number that will be answered on a 24 hour basis each day of the week, for the duration of the service.

E Submit copies of equipment and material warranties to Designer before final payment.

F At end of guarantee period, transfer manufacturers' equipment and material warranties still in force to User Agency.

G This Paragraph shall not be interpreted to limit User Agency's rights under applicable codes and laws and under this Contract.

H Part 2 Paragraphs of this Specification may specify warranty requirements that exceed those of this Paragraph.

I Use of systems provided under this Section for temporary services and facilities shall not constitute Final Acceptance of work nor beneficial use by User Agency, and shall not institute guarantee period.

J Provide manufacturer's engineering and technical staff at site to analyze and rectify problems that develop during guarantee period immediately. If problems cannot be rectified immediately, advice Designer in writing, describe efforts to rectify situation, and provide analysis of cause of the problem. Designer will suggest course of action.

1.13 RECORD DRAWINGS

A Comply with requirements specified in Section 017700 – PROJECT CLOSEOUT and SECTION 017839-PROJECT RECORD DOCUMENTATION.

B Drawings shall show record condition of details, sections, riser diagrams, control changes and corrections to schedules. Schedules shall show actual manufacturer and make and model numbers of final equipment installation.

1.14 BULLETINS, MANUALS, AND OPERATING INSTRUCTIONS, AND PROTECTION

A Obtain at time of purchase of equipment, three copies of operation, lubrication and maintenance manuals for all items. Assemble literature in coordinated manuals with additional information describing combined operation of field assembled units, including as-built wiring diagrams. Manual shall contain names and addresses of manufacturers and local representatives who stock or furnish repair parts for items or equipment. Divide manuals into three sections or books as follows:

1 Directions for and sequence of operation of each item of Fire Protection systems. Sequence shall list valves, switches, and other devices used to start, stop and control system. Detail procedure to be followed in case of malfunctions.

2 Detailed maintenance and troubleshooting manuals containing data

furnished by manufacturer for complete maintenance. Include copy of balancing report.

3 Lubrication instructions detailing type of lubricant, amount, and intervals recommended by manufacturer for each item of equipment. Include additional instructions necessary for implementation of first class lubrication program. Include approved summary of lubrication instructions in chart form, where appropriate.

B Furnish three copies of manuals to Designer for approval and distribution to Construction Manager. Deliver manuals no less than 30 days prior to acceptance of equipment to permit User Agency's personnel to become familiar with equipment and operation prior to acceptance. Refer to section 017823-Operation and Maintenance Data.

C Provide framed and glazed charts as follows: mount as directed by Designer.

1 Flow diagrams from first part of manual as described above.
2 Valve directory.
3 Lubrication chart from third part of manual.

D Operating instructions: Upon completion of installation or when Owner accepts portions of building and equipment for operational use, instruct User Agency's operating personnel in any or all parts of various systems. Instructions shall be performed by factory-trained personnel. User Agency shall determine which systems require additional instructions. Duration of instructions shall take equipment through complete cycle of operation (at least five working days). Make adjustments under operating conditions. Fire Protection subcontractor shall videotape all instructions given to the owner, and shall provide up the two hours of videotape instructions. Three copies of the videotaped instructions shall be submitted by the owner.

E Each contractor shall be responsible for his work and equipment until finally inspected, tested, and accepted. Carefully store materials and equipment which are not immediately installed after delivery to site. Close open ends of work with temporary covers or plug during construction to prevent entry of obstructing material.

F Each separate contractor shall protect the work and material of other trades that might be damaged by his work or workmen and make good all damage thus caused.

1.15 COORDINATION DRAWINGS

A. This fire protection contractor shall prepare coordination drawings clearly showing how his work is to be installed in relation to the other trades, including sections and details under Section 01 31 00 – PROJECT MANAGEMENT AND COORDINATION.

1.16 SPRINKLER WORKING PLANS

A Definition: Working plans are the installation shop drawings required by NFPA Standard 13 and normally prepared by the installing sub-contractor.

B Prepare working plans according to the requirements of NFPA Standard 13. Working plans and hydraulic calculations shall be prepared by a NICET-certified Level III or IV automatic sprinkler system engineering technician or be stamped by a professional engineer registered in the jurisdiction of the Project.

1 Working Plans shall be stamped and signed by a Professional Engineer when required by the approving authority.

C Submit working plans to the authorities having jurisdiction for approval, including:

1 Building Department.
2 Fire Department.
3 User Agency's Insurance Underwriter.
4 Designer.

D Deviation from the approved plans will require re-approval by the reviewing authorities.

E Prepare sprinkler head layout plans on reflected ceiling plans for submission to the Designer before submission of the working plans.

F Submit working plans and hydraulic calculations to the Designer in one complete package, after review by the other authorities having jurisdiction. Plans submitted without review stamps or hydraulic calculations will be returned without review.

1.17 WELDER REQUIREMENTS

A Before any welding is performed, Contractor shall submit three copies of the welding procedure specification for all metals included in the Work together with proof of qualifications as outlined in ANSI B31.1, ANSI B31.5 and ASME Boiler Code Section IX.

B Before any welder or operator shall perform any welding the Contractor shall submit three copies of the Welder's Performance Qualification Record in conformance with ANSI B31.1 and ANSI B31.5, and ASME Section IX, showing that the welder was tested under the accepted procedure specification submitted by the Contractor. In addition the Contractor shall submit each welder's assigned number, letter, or symbol which shall be used to identify the work of the welder which shall be affixed immediately upon completion of the weld. Welders making defective welds after passing a qualification test shall be required to take a re-qualification test.

C Welders failing the re-qualification tests shall not be permitted to work under this contract.

D Welding procedures, welders, and welding operators previously qualified by test

may be accepted for this contract without re-qualification provided that all the conditions specified in ANSI B31.1 and ANSI B31.5 are met before a procedure is used.

1.18 FIRE PROTECTION SYSTEMS COMMISSIONING AND ACCEPTANCE

A. The entire Fire Protection System shall be fully operational and under automatic control prior to acceptance by the Owner. All equipment shall be test operated, calibrated and adjusted by the Section 210001 subcontractor and the proper operation of all components of the fire protection system shall be demonstrated to the Owner and the owner's commissioning agent at no additional cost to the owner. The Section 210001 Fire Protection Subcontractor shall secure a letter of Acceptance of the fire protection system operation Demonstration from the owner. A copy of said letter shall be submitted to the Architect prior to formal acceptance of the Fire protection

1.19 SEISMIC RESTRAINTS

A. Installation of Fire Protection equipment, accessories and components shall be in accordance with the Seismic Requirements identified in NFPA 13, 2019. Refer to Part Two (2) of the Specifications for further information.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering fire protection system products which may be incorporated in the work include, but are not limited to, the following:

1. Gate/Butterfly Valves:
   Kennedy Valve, Div of ITT Grinnell Valve Co., Inc.
   Reliable Sprinkler Corp.
   Victaulic Company of America
   Viking Corp.

2. Swing Check Valves:
   Kennedy Valve, Div of ITT Grinnell Valve Co., Inc.
   Reliable Sprinkler Corp.
   Victaulic Company of America
   Viking Corp.

3. Grooved Mechanical Couplings:
   Grinnell
   Victaulic
   Gustin-Bacon

4. Water Flow Indicators:
   Reliable Automatic Sprinkler Co., Inc.
   Reliable Sprinkler Corp.
   Victaulic Company of America
   Viking Corp.

5. Back flow Preventer:
   Ames Company, Inc.
   Kennedy Valve, Div of ITT Grinnell Valve Co., Inc.
   Victaulic Company of America

6. Alarm Check Valves:
   Reliable Sprinkler Corp.
   Victaulic Company of America
   Viking Corp.

7. Fire Department Connection:
   Guardian Fire Equipment, Inc.
   Star Sprinkler Corp.
   Viking Corp.

8. Sprinkler Heads:
   Tyco.
   Reliable Sprinkler Corp.
   Victaulic Company of America

Viking Corp.

2.2 PIPING, FITTINGS AND JOINTS

A. Fire Line Piping:

1. Black steel Schedule 40, ASTM A53 with flanged, threaded, or grooved joints. Galvanized for Dry System.
2. Black steel Schedule 10, ASTM A135 lightwall with roll-grooved fittings. Galvanized for Dry System.

B. Sprinkler Piping:

1. 1-1/2" inches and smaller: ASTM 135 Schedule 40 black steel with threaded joints. Galvanized for Dry System
2. 2 inches and larger: ASTM 135 Schedule 10 lightwall with roll grooved joints or Schedule 40 black steel with grooved or threaded joints. Galvanized for Dry System.

C. Fittings:

1. Ductile Iron: ASTM A-536.
2. Malleable Iron: ANSI B16.3.
3. Steel: ANSI B16.11.
4. Cast Iron: ANSI B16.4. (Not for use in dry system.)
5. All dry system fittings shall be Galvanized.

D. Grooved Fittings and Couplings:

1. Grinnell Fig. 7000, Gustin-Bacon No. 105 or Victaulic Style 75.
2. Compatibility: Couplings and fittings shall be of a single manufacturer or shall be certified as compatible by both manufacturers.

E. Braided Flexible Expansion Loops

1. Braided flexible expansion loops shall consist of two parallel sections of braided metal hose, a 180 degree return bend, with inlet and outlet 90 degree elbow connections. The loops shall be engineered to move in all three planes, and shall impart no thrust loads to system anchors.

2. Materials of construction of the braided metal hoses are to be a type 321 stainless steel with a type 304 stainless steel braid. End fittings shall be consistent with pipe material and connection fittings.

3. Loops shall be designed to meet the design pressure, temperature, and movement requirements for the system. Loops shall be capable of accommodating piping system and equipment movements and vibration as needed.

4. Loops shall be furnished with factory supplied hanger / support lug located

at the bottom of the 180 degree return. Also provided at the bottom return will be a plugged FPT to be used for a drain or air release vent.

2.3 JOINING MATERIALS

A. Welding Materials: Comply, with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

1. Brazing Filter Metals: AWS A5.8, Classification Bag1 (Silver).
2. Solder Filter Metals: ASTM B 32, 95-5 Tin Antinomy.

B. Gasket Materials: Thickness, material, and type suitable for fluid or gas to be handled, and design temperatures and pressures.

2.4 SLEEVES, INSERTS AND ESCUTCHEONS

A. All penetration for fire protection elements through fire rated partitions shall be fire-stopped by the Fire protection Sub Contractor. All penetrations for fire protection elements through the non-fire rated partition shall be sealed with mineral wool insulation and acoustical sealant by the fire protection subcontractor.

B. All pipes passing through floors, walls, or partitions shall be provided with sleeves having an internal diameter of approximately one inch larger than the outside diameter of the pipe or insulation on covered lines.

C. Sleeves through floors and through exterior, structural and fire-rated construction shall be hot-dipped galvanized Schedule 40 steel pipe.

D. Sleeves through partitions and non-fire-rated construction shall be 25 gauge galvanized steel with lock longitudinal seams, or approved plastic pipe.

E. Provide waterproofing membrane locking devices at slab on grade floors. Provide 150 lb. Slip-on welding flanges or approved equal waterstop device at exterior wall penetrations.

F. Inserts shall be individual or strip type of pressed steel construction with accommodation for removable nuts and threaded rods up to 3/4 inch diameter, permitting lateral adjustment. Individual inserts shall have an opening at the top to allow reinforcing rods up to 2 inch diameter to be passed through the insert body. Strip inserts shall have attached rods with hooked ends to allow fastening to reinforcing rods.

G. Unless otherwise specified herein, escutcheons shall be cast brass chrome plated type and provided with a set screw to properly hold escutcheon in place.

H. Where piping passes below grade beams, provide a ductile iron sleeve three sizes larger than the pipe being served. Sleeve shall be a minimum of six feet in length.

I. The void between sleeves and piping passing through all interior above grade fire

rated partitions and floor slabs shall be filled with a two hour fire rated mastic.

2.5 GENERAL DUTY VALVES

A. Gate valves, 2 inches and smaller shall be outside screw and yoke, bronze, rising stem, wedge disc type, threaded, conforming to MSS SP-80. Gate valve 2-1/2 inches and larger shall be iron body, bronze trim, outside screw and yoke, flanged, UL/FM listed conforming to MSS SP-70. All valves shall be UL listed for at least 175 psi working water pressure (wwp).

B. Globe and angle valves may be used as auxiliary valves (drain valves, test valves, trim valves and valves on compressed air piping) for diameters not over 2 in. They shall be bronze, rising stem, with bronze disc, threaded, conforming to MSS SP-80 Class 150.

C. Check valves shall be swing type except as noted. Valves 2 inches and smaller shall be bronze, regrinding type with renewable disc, screwed caps, threaded, class 150 conforming to MSS SP-80. Check valves 2-1/2 inches and greater shall be iron body, bronze trim, bolted cover, flanged, conforming to MSS SP-71, UL listed for 175 psi wwp.

D. Butterfly valves shall be indicating type, Cast or ductile iron body with flanges, grooved or wafer end connections conforming to UL 1091 listed for 175 PSI.

2.6 SPECIALTY VALVES

A. Wet riser check valves shall be approved vertical type for wet systems, complete with drain valve and glycerin filled pressure gauges. Valve internal components shall be replaceable without removing valve from the installed position. Similar to Victaulic Series 717R or equal as approved; and UL/FM Global approved.

B. Dry Pipe Valves: differential type, 175 psig working pressure, and have cast iron, flanged inlet and outlet, bronze seat with AO ring seals, single hinge pin and latch design. Provide trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gauges, priming chamber attachment, and fill line attachment.

C. Air-Pressure Maintenance Device, Dry-Pipe System: An automatic device to maintain the correct air pressure in a dry-pipe system or deluge system. System shall have shut-off valves to permit servicing without shutting down the sprinkler system, bypass valve for quick system filling, pressure regulator or switch to maintain system pressure, strainer; pressure ratings 14 to 60 psig adjustable range, and 175 psig maximum inlet pressure. Electrical ratings shall match compressor ratings. Preaction system: The automatic sprinkler piping is supervised by compressed air from a source installed inside the preaction cabinet. The air supply must be regulated and of the proper size in order to be able to restore normal system air pressure within 30 minutes.

D. Double check valve assembly (Back flow Preventer) shall be UL listed FM approved, complete with test kit and spare parts kit. The Double Check Valve Assembly shall

consist of two independent tri-link check modules within a single housing, sleeve access port, four test cocks and two drip tight shut-off valves. Tri-link checks shall be removable and serviceable, without the use of special tools. The housing shall be constructed of Schedule 40 stainless steel pipe with groove end connections. Tri-link checks shall have reversible elastomer discs and in operation shall produce drip tight closure against reverse flow caused by backpressure or backsiphonage. This Contractor shall act as the Owner's agent in seeking approval from the Department of Environmental Protection or its designee. The double check valve assembly shall be installed in a horizontal position with the top of the check valves a minimum of 30 inches and a maximum of 53 inches from the floor. There must be at least 12 inches clearance from any wall. Pressure gauge assemblies, including needle shutoff valve and a snubber, shall be installed on the supply and discharge side of each backflow preventer assembly. Test and certify double check valve device. Submit all plans, specifications and applications required for approval, pay all fees. Approvals shall be secured prior to the purchase and installation of the double check valve assembly. Secure all local permits that also may be required.

2.7 AUTOMATIC SPRINKLERS

A. Sprinkler Heads: Glass Bulb type, and style as indicated or required by the application. Unless otherwise indicated, provide heads with nominal 1/2 inch discharge orifice, for "Ordinary" temperature range. All sprinkler heads shall be quick response type.

B. Sprinkler Heads Finishes: Provide heads with the following finishes:

1. Upright, Pendent, and Sidewall Styles: chrome plated in finish spaces, exposed to view; rough bronze finish for heads in unfinished spaces and not exposed to view. Heads shall be wax-coated where installed exposed to acids, chemicals, or other corrosive fumes.
2. Concealed Style: chrome plated, provide white cover plates except in areas noted in drawings as custom color cover plates. Coordinate with Architect for color requirements.
3. Refer to Architectural drawing for ceiling types.

C. Sprinkler Head Cabinet: Finished steel cabinet, suitable for wall mounting, with hinged cover.
1. The cabinet shall be provided with spare sprinkler heads, sprinkler wrench and list sprinklers used in the property.
2. Follow requirements from NFPA 13, 2013 Section 6.2.9.

D. Flexible Stainless-Steel Sprinkler Fitting System**:** In lieu of rigid pipe offsets or return bends for sprinkler drops, Multiple-Use Flexible Stainless-Steel Sprinkler Drop System [with captured coupling] may be used to locate sprinklers as required by final finished ceiling tiles and walls. The drop system shall consist of a braided type 304 stainless steel flexible tube, zinc plated steel Male threaded nipple Groove Style coupling for connection to branch-line piping, and a zinc plated steel reducer with a female thread for connection to the sprinkler head.

The drop shall include a UL approved braided hose with a bend radius to 2" to

allow for proper installation in confined spaces. Union joints shall be provided for ease of installation. The flexible drop shall attach to the ceiling grid using a one-piece open gate bracket. The bracket shall allow installation before the ceiling tile is in place. The braided drop system is UL listed and FM Approved for sprinkler services.

2.8 FIRE DEPARTMENT CONNECTIONS

A. Fire Department connection shall be flush mount Storz style inlet body with hard coated aluminum with Storz on one end and female national pipe thread on the other. Chrome plate lettered with the approved signage. Provide blind cap and chain. The connection's lettering and threads shall match Local Fire Department requirements. Confirm finish with Architect prior to ordering.

2.9 FIRE DEPARTMENT VALVES

A. Fire Department Hose Valves shall be 2-1/2" in size with cap and chain. Confirm thread requirements with the local fire department.

2.10 ALARM DEVICES

A. General: Types and sizes shall mate and match piping and equipment connections.

B. Water Flow Indicators: Vane type waterflow detector, rated to 250 psig; designed for horizontal or vertical installation; have 2-SPDT circuit switches to provide isolated alarm and auxiliary contacts, 7 ampere 125 volts AC and 0.25 ampere 24 volts DC; complete with factory-set, field-adjustable retard element to prevent false signals, and tamper-proof cover which sends a signal when cover is removed.

C. Electric Alarm: Electrically operated, red enameled gong with pressure alarm switch.

D. Supervisory Switches: SPST, normally closed contacts, designed to signal valve in other than full open position.

2.11 PIPE SLEEVES, HANGERS AND SUPPORTS

A. Provide pipe supports, sway braces, hangers, and clamps conforming to NFPA 13 and listed by UL. Hangers for piping of sizes 4 inches and smaller shall be Carpenter & Paterson Figure No. 800 adjustable swivel ring, black steel and hanger rods with machine threads. Hangers for piping of sizes larger than 4 inches shall be the adjustable clevis hanger type, steel with extension rod to structure, Carpenter-Paterson Figure No. 100. All hangers shall be UL/FM approved. Other manufacturers are Crane Company, Tolco Company or approved equal.

B. Pipe sleeves shall be installed and properly secured at all points where pipes pass through masonry, concrete or wood. Pipe sleeves shall be of sufficient diameter to provide approximately 1/4 inch clearance. Pipe sleeves through masonry partitions and floors shall be Schedule 40 galvanized pipe. Wall sleeves shall have chromium-plated escutcheons with set screws or clips for firmly holding in place. Sleeves

through walls shall end flush with surface of walls. Sleeves in floors shall extend one inch above the floor and after installation of piping shall be packed and made water tight. Provide core drilling. Core openings shall have Link-Seal fire rated penetration closures. Sleeves in exterior walls shall have water stop plates, shall end flush with the surface of the walls and shall have Link-Seal penetration closures.

C. Where pipes penetrate fire rated floors and partitions, the openings shall be packed with a material which will maintain the integrity of the fire rating.

D. Provide all necessary design and materials for restraint and protection of piping and devices against damage where subject to movement in horizontal or vertical plane. All isolation and bracing devices shall be the product of a single manufacturer

2.12 ACCESS DOORS AND FRAMES

A. Furnish access doors and frames for walls and ceilings to General Trades Subcontractor for installation. Size as required for access and maintenance, minimum 16 by 16 inches.

2.13 FIRE STOPPING

A. Seal openings of fire rated construction with a material or product that has been tested at an independent testing laboratory, such as UL, FM, Fire stopping shall conform to ASTM E-814 and UL 1479, with fire ratings equal to or exceeding the fire rating of the construction involved. Fire stopping shall be UL classified, and shall be similar to the 3M brand Fire Barrier Penetration Sealing Systems, or approved equivalent. Fire stopping of this type shall also be utilized for openings through smoke rated construction.

1. Comply with Division 07 Section “Penetration Firestopping.”

B. If desired by the Contractor and approved by local codes, the “Pro-Set” piping penetration system also may be utilized. Penetration system shall be UL certified and shall be the “Pro-Set” System A. Firestop coupling (sleeve) shall be filled with ceramic fiber material to provide insulation and fire stopping. System shall be capable of maintaining a 3-hour fire rating. Penetration system shall be secure, waterproofed, fire rated and smoke proof and shall allow for pipe expansion and contraction.

C. Smoke proof and Seal all fire protection pipes penetration in corridor wall whither it is rated or unrated wall construction.

2.14 IDENTIFICATION AND VALVE TAGS

A. All piping, except that piping which is within inaccessible chases, shall be identified with semi-rigid plastic identification markers equal to Seton Setmark pipe markers. Direction of flow arrows are to be included on each marker. Each marker background shall be appropriately color coded with a clearly printed legend to identify the contents of the pipe in conformance with the “Scheme for the Identification of Piping Systems” (ANSI A13.1-1981). Setmark snap-around markers shall be used for overall diameters up to six (6) inches and strap-around markers shall be used above six (6) inch overall diameter.

Markers shall be located adjacent to each valve, at each branch, at each cap for future, at each riser take off, at each pipe passage through wall, at each pipe passage through floors, at each pipe passage to underground and on all vertical and horizontal piping at 20 foot intervals maximum.

B. All valves shall be designated by distinguishing numbers and letters carefully coordinated with a valve chart. Valve tags shall be 19 gauge polished brass, 1-1/2 inch diameter with stamped black filled letters similar to Seton Style No. 4522, or approved equal. Lettering shall be 1/4 inch high for type service and 1/2 inch for valve number. Tag shall be attached to valves with approved brass “S” hooks, or brass jack chain. Whenever a valve is above a hung ceiling, the valve tag shall be located immediately above the hung ceiling.

C. Furnish a minimum of two typed valve lists to be framed under glass or Plexiglas. Each chart shall be enclosed in an approved .015 inch thick plastic closure for permanent protection. Valve numbers shall correspond to those indicated on the Record Drawings and on the printed valve lists. The printed list shall include the valve number, location and purpose of each valve. It shall state other necessary information such as the required opening or closing of another valve when one valve is to be opened or closed. Printed frame valve lists shall be displayed in each Mechanical Room or in a location designated by the Owner.

D. Equipment nameplates shall be 3/4 inch by 2-1/2 inch long .02 inch aluminum with a black enamel background with engraved natural aluminum letters similar to Seton Style 2065-20. Nameplate shall have pressure sensitive taped backing.

E. Provide a brass wall plaque, minimum .020 inch thickness, secured to the exterior wall just above the grade line for all service entrances and exits that are buried. Sample of the label shall be FIRE SERVICE BELOW.

2.15 LOW PRESSURE SWITCH

A. In addition to the normal water flow devices for actuating the sprinkler alarm system, a low pressure switch shall be inserted into the city side of the backflow prevention device so that if there is an interruption in the water supply to the protected property, the drop in pressure caused by a sprinkler head operating will cause the low pressure switch to actuate the tripping circuit.

2.16 SEISMIC RESTRAINTS

A. General

1. This section provides Seismic Control for the "equipment" as listed below.

2. It is the intent of this specification to provide restraint of non-structural building components. Restraint systems are intended to withstand the stipulated seismic accelerations applied through the component’s center of gravity.

3. The work in this section includes the following:
   a. Seismic restraints for equipment.

b. Seismic separation assemblies at seismic joints.
c. Certification of seismic restraint designs and installation supervision.

4. Definitions

a. The term EQUIPMENT will be used throughout this specification and it includes ALL non-structural components within the facility and/or serving this facility, such as equipment located in outbuildings or outside of the main structure on grade within five feet of the foundation wall. Equipment buried underground is excluded but entry of services through the foundation walls is included. Equipment referred to below is a partial list of equipment for reference. (Equipment not listed are still included in this specification)

- Piping

5. Life safety systems defined

a. All systems involved with fire protection including sprinkler piping, fire pumps, jockey pumps, fire pump control panels, service water supply piping, water tanks.
b. All systems involved with and/or connected to emergency power supply including all circuits to fire protection systems.

6. Positive Attachment

a. Positive attachment is defined as a support location with a cast-in or wedge type expansion anchor, a double sided beam clamp, a welded or through bolted connection to the structure.

7. Transverse Bracing

a. Restraint(s) applied to limit motion perpendicular or angular to the centerline of the pipe, duct, or conduit.

8. Longitudinal Bracing

a. Restraint(s) applied to limit motion along the centerline of the pipe, duct, and conduit.

B. Submittal Data Requirements

1. Submittals

a. Catalog cuts or data sheets on specific restraints to be utilized detailing compliance with the specification. Reference "TYPE" as per "PRODUCTS" section of this specification.
b. An itemized list of all equipment. Detailed schedules showing seismic restraints proposed for each piece of equipment, referencing material and seismic calculation drawing numbers.

2. Shop Drawings

    a. When walls and slabs are used as seismic restraint locations, details of acceptable methods must be included.
    b. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.
    c. Coordinated or contract drawings shall be marked-up with the specific locations and types of restraints shown for all pipe. Rod bracing at various installation angles and assigned load at each restraint location shall be clearly delineated. Any and all tributary loads, Eg: Fire Protection pipe runouts shall be considered for proper restraint sizing.
    d. For ceiling suspended equipment provide minimum/maximum installation angle allowed for restraint system as well as braced and unbraced rod lengths at each allowable installation condition.

C. Manufacturer's Responsibility

1. Manufacturer of seismic control equipment shall have the following responsibilities:

    a. Determine seismic restraint sizes and locations.
    b. Provide equipment seismic restraints as specified.
    c. Provide installation instructions, drawings and field supervision to insure proper installation and performance of systems.

D. Related Work

1. Housekeeping Pads

    a. Housekeeping pad attachment shall be by the project structural engineer. Material and labor required for attachment and construction shall be by the Concrete section contractor.

    b. Housekeeping pads shall be coordinated with the Seismic Restraint vendor and sized to provide a minimum edge distance of 10 bolt diameters of clearance all around the outermost anchor bolt to allow for the use of full anchor ratings.

2. Supplementary Support Steel

    a. Contractor shall supply supplementary support steel and connections for all equipment.

3. Attachments

    a. Contractor shall provide restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, in accordance with the requirements of the Seismic Restraint vendor.

TABLE A

"G" FORCES FOR VARIOUS CONDITIONS (SEISMIC ZONE 2 - AV > 0.1 ≤ 0.2)		
PIPE	RIGIDLY MOUNTED EQUIPMENT	ALL LIFE SAFETY EQUIPMENT
.25	.40	.60

E. Materials

1. Devices

a. All seismic restraint devices described in this section shall be the product of a single manufacturer. Mason Industries is the base manufacturer of these specifications; products of other manufacturers are acceptable provided their systems strictly comply with intent, structural design and performance of the Base Manufacturer.

2. Seismic Restraint Types

a. All seismic restraint devices shall be capable of accepting, without failure, the "G" forces as determined by the seismic certification and calculations as described in the "SUBMITTAL DATA REQUIREMENTS" section of these specifications.

b. All seismic restraint devices

(1) Shall maintain the equipment in a captive position.
(2) Shall have provisions for bolting and/or welding to the structure.

3. Seismic Restraint Types

a. TYPE I: Not Used

b. TYPE II: Not Used

c. TYPE III: Restraints for suspended systems

(1) Multiple 7 x 19 strand galvanized cable rope.
Mason Industries Type SCB
(2) Structural steel strut type with approved fastening devices to equipment and structure.
Mason Industries Type SSB
(3) Steel angles (by contractor) shall be provided to prevent rod bending of hung equipment where indicated by the Seismic Restraint vendor's submittals. Steel angles shall be attached to the rods with a minimum of three ductile iron clamps at each restraint location. Welding of support rods to angles is not

acceptable. Rod clamp assemblies shall have Anchorage Preapproval "R" number from California OSHPD.
Mason Ind. Model "SRC".

(4) Pipe clevis cross braces are required at all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the clevis cross bolt. Clevis cross braces shall have Anchorage Preapproval "R" number from California OSHPD.
Mason Ind. Model "CCB".

d. TYPE IV: Not Used

e. TYPE V: Rigid attachment to structure utilizing wedge type expansion anchors for bolting and steel plates, either cast-in or anchored with wedge type expansion bolts, for welding. Powder shots are not acceptable. Concrete anchor bolt spacing shall be in accordance with manufacturer's published standards.

F. Installation

1. Seismic restraint systems must be installed in strict accordance with the manufacturer's written instructions, all submittal data, and the approved seismic design certified by the qualified registered professional engineer.

2. Equipment Installation

a. Housekeeping pads for equipment in this section must be properly doweled or bolted, using wedge type expansion bolted to the structure to meet the acceleration criteria. Anchor equipment or isolators to housekeeping pads, see RELATED WORK.

3. Seismic Restraints

a. Installation

(1) All floor mounted equipment shall be snubbed, anchored, bolted or welded to the structure to comply with the required acceleration. Calculations that determine that equipment movement may be less than the operating clearance of snubbers (restraints) do not preclude the need for snubbers. All equipment must be positively attached to the structure.

(2) All suspended equipment shall be two or four point independently braced with TYPE III restraints. Rod bracing shall be installed as per approved submittals and shop drawings. Equipment less than 50 lbs. is excluded.

(3) All horizontally suspended pipe shall use RESTRAINT TYPE III. Spacing of seismic bracing shall be as per TABLE B at the end of this section.

(4) For all trapeze supported piping the individual pipes must be transversely and vertically restrained to the trapeze support at the designated restraint locations.

(5) For overhead supported equipment, over stress of the building structure must not occur. Bracing may occur from:

(a) Flanges of structural beams.
(b) Upper truss chords in bar joists.
(c) Cast in place inserts or drilled and shielded inserts in concrete structures.

(6) Pipe Risers

(a) Where pipes pass through cored holes, core diameters to be a maximum of 2 inches larger than pipe O.D. for pipes less than 3” in diameter and 4 inches larger than pipe O.D. for pipes 4” and greater in diameter , including insulation. Cored holes must be packed with resilient material or fire stop as specified in other sections of this specification and/or state and local codes. No additional horizontal seismic bracing is required at these locations.

(b) An alternate method to (a) above is to install a flexible coupling 12” above and 24” below where the pipe penetrates a slab. Cored holes must be packed with resilient material or fire stop as specified in other sections of this specification and/or state and local codes.

(c) Pipe risers through cored holes require a riser clamp at each floor level on top of the slab attached in a seismically approved manner for vertical restraint.

(d) Pipe in pipe shafts require structural steel attached in a seismically approved manner at each floor level and a riser clamp at each floor level on top of, and fastened to the structural steel. The riser clamp and structural steel must be capable of withstanding all thermal, static and seismic loads.

(7) All floor or wall mounted equipment and tanks shall use RESTRAINT TYPE III or V.

(8) Where base anchoring of equipment is insufficient to resist seismic forces, restraint TYPE III shall be located above the unit’s center of gravity to suitably resist "G" forces specified.

(a) Vertically mounted tanks may require this additional restraint.

(9) A rigid piping system shall not be braced to dissimilar parts of a building or two dissimilar building systems that may respond in a different mode during an earthquake. Examples: Wall and roof; solid concrete wall and a metal deck with lightweight concrete fill or pipes crossing a building expansion joint.

(10) Piping that crosses a building expansion joint must be provided with a seismic separation assembly, regardless of size, in accordance with NFPA 13, 2019 Edition. This can be in the form of a 6 ell expansion loop using flexible couplings as shown in NFPA 13, 2019 Edition, or a UL Listed seismic separation assembly equal to metraflex fire loop.

4. Exclusions for Seismic Bracing on Life Safety Equipment

a. Piping

(1) Fire protection standpipe, risers, and branches less than 2-1/2 inches in diameter unless required by NFPA 13, 2019 Edition.

G. Inspection

1. Upon completion of installation of all vibration isolation and seismic restraint devices, the owner may elect to contract and outside consultant at the owner's expense to review the installation. Any deficiencies in the installation will be corrected immediately at the contractor's expense.

TABLE B	**SEISMIC BRACING TABLE**		
EQUIPMENT	**ON CENTER SPACING (Max)**		**WITHIN EACH CHANGE OF DIRECTION (LARGER OF. . .)**
	TRANSVERSE	**LONGITUDI-NAL**	
	(Mains regardless of size)		
PIPE (Threaded, Welded, Soldered or Grooved)			
To 16"	40 Feet	80 Feet	10 Feet or 15 Diameters

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine rough-in for fire hose valves and cabinets to verify actual locations of piping connections prior to installing cabinets.

B. Examine walls for suitable conditions where cabinets are to be installed.

C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PIPE APPLICATIONS

A. Install piping in accordance with NFPA 13 for sprinkler systems.

B. Install Schedule 40 steel pipe with threaded joints and fittings for 2-inch and smaller, and with welded joints for 2-1/2 inch and larger.

C. Install Schedule 40 steel pipe with roll-grooved ends and grooved mechanical couplings for piping 2-inch and smaller.

D. Install Schedule 10 steel pipe with roll-grooved ends and grooved mechanical couplings for piping 2-1/2 inch and larger.

3.3 PIPING INSTALLATIONS

A. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. So far as practical, install piping as indicated.

1. Deviations from approved “Working Plans” for sprinkler piping, require written approval of the authority having jurisdiction. Written approval shall be on file with the Designer prior to deviating for the approved “Working Plans.”

B. Install sprinkler piping to provide for system drainage in accordance with NFPA 13.

C. Use approved fittings to make all changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

D. Install unions in pipes 2-inch and smaller, adjacent to each valve. Unions are not required on flanged devices or in piping installations using grooved mechanical couplings.

E. Install flanges or flange adaptors on valves, apparatus, and equipment having 2-1/2 inch and larger connections.

F. Hangers and Supports: Comply with the requirements of NFPA 13 and NFPA 14. Hanger and support spacing and locations for piping joined with grooved

mechanical couplings shall be in accordance with the grooved mechanical coupling manufacturer's written instructions, for rigid systems. Provide protection from damage where subject to earthquake in accordance with NFPA 13.

G. Make connections between underground and above-ground piping using an approved transition piece strapped or fastened to prevent separation.

H. Install mechanical sleeve seal at pipe penetrations in basement and foundation walls.

I. Install test connections sized and located in accordance with NFPA 13 complete with shutoff valve. Test connections may also serve as drain pipes.

J. Install pressure gage on the riser or feed main at or near each test connection. Provide gage with a connection not less than 1/4 inch and having a soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and where they will not be subject to freezing.

3.4 PIPE JOINT CONSTRUCTION

A. Welded Joints: AWS D10.9, Level AR-3.

B. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe, fittings, and valves as follows:

1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.

2. Align threads at point of assembly.

3. Apply appropriate tape or thread compound to the external pipe threads.

4. Assemble joint to appropriate thread depth. When using a wrench on valves, place the wrench on the valve end into which the pipe is being threaded.

5. Damaged Threads: Do no use pipe with threads which are corroded, or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

6. Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly to appropriate torque specified by the bolt manufacturer.

7. Mechanical Grooved Joints: Cut or roll grooves on pipe ends dimensionally compatible with the couplings.

8. Brazed Joints: Comply with the procedures contained in the AWS "Brazing Manual."

   a. WARNING: Some filler metals contain compounds which produce highly toxic fumes when heated. Avoid breathing fumes. Provide adequate ventilation.

9. Soldered Joints: Comply with the procedures contained in the Copper Development Association "Handbook for Fire Sprinkler Systems."

10. End Treatment: After cutting pipe lengths, remove burrs and fins from pipe ends.

3.5 VALVE INSTALLATION

B. General: Install fire protection specialty valves, fittings, and specialties in accordance with the manufacturer's written instructions, NFPA 13 and 14, and the authority having jurisdiction.

C. Gate Valves: Install supervised-open gate valves so located to control all sources of water supply except fire department connections. Where there is more than one control valve, provide permanently marked identification signs indicating the portion of the system controlled by each valve.

D. Install check valves in each water supply connection.

E. Alarm Check Valves: Install valves in the vertical position, in proper direction of flow including the bypass check valve and retard chamber drain line connection. Install valve trim in accordance with the valve manufacturer's appropriate trim diagram. Test valve for proper operation.

3.6 DRAINS AND AUXILIARY DRAINS

A. Provisions shall be made to properly drain all parts of the system. Follow requirements of NFPA 13, 2019 Section 16.2.4.

B. Provide splash block at the exterior discharge of each main drain.

C. Auxiliary drain connections shall be provided when a change in piping direction prevents drainage of sections of branch lines or mains through the main drain valve. Follow requirements of NFPA 13, 2019 Section 16.2.5.

D. Inspector's test and drain: Wet system test pipe shall not be less than 1 inch in diameter terminating in a smooth bore corrosion resistant orifice giving a flow equivalent to one sprinkler shall be provided for each system. Each test connection valve shall be ready accessible and labeled. The discharge shall be to the outside, to an open drain connection capable of accepting full flow under system pressure or to another location where water damage will not result.

3.7 SPRINKLER HEAD INSTALLATIONS

A. Use proper tools to prevent damage during installations.

3.8 FIRE DEPARTMENT CONNECTION INSTALLATIONS

A. Install automatic drip valves at the check valve on the fire department connection to the mains.

B. Install mechanical sleeve seal at pipe penetration in outside walls.

3.9 FIELD QUALITY CONTROL

A. Flush, test, and inspect sprinkler systems in accordance with NFPA 13.

B. Flush, test, and inspect underground fire protection piping in accordance with NFPA 24.

C. Replace piping system components which do not pass the test procedures specified, and retest repaired portion of the system.

3.10 TESTING

A. Testing and flushing of the fire protection systems shall be done at the expense of Fire protection subcontractor and with equipment furnished by him. Testing shall be done in the presence of duly authorized inspectors and representatives of the owner’s project manager within forty-eight (48) hour notice given those authorities. Prior to testing, the system shall be thoroughly flushed with clean water.

B. The system shall be repaired and retested until made perfect, without additional expense to THE CONTRACT.

C. To test piping, subject it to a three-hour hydraulic test of 200 psi, and as by N.F.P.A. and the User Agency's Insurance Underwriter. Piping shall be repaired until such tests show no leaks. Where required, and depending on the building timing and schedule, the system may be required to be tested without final swing elbows and heads installed. In this case, a second test will be required upon installation of swing elbows and heads.

D. Material and test certificates must be signed by fire protection contractor prior to and upon completion of testing. Final test reports must be approved in writing by local authorities.

E. Results of tests shall be recorded and submitted using the forms in NFPA #13 & #14, for review by the Engineer. The Material and Test Certificate shall also be sent to the Owners Project Manager and User Agency's Insurance Underwriter.

F. Fire protection subcontractor shall ensure that the underground piping from the street main and service entry piping has been tested to 200 psig in accordance with NFPA 24 requirements. This shall be recorded separately from the interior

piping. Coordinate this with the site water piping installer.

G. Provide all necessary and appropriate personnel to participate in and coordinate fire protection systems with all fire alarm testing, or other systems testing which may interface with fire protection system. Participation shall include all preliminary testing, walk-through testing prior to official walk-through testing and any re-testing if required.

H. Where Insurance Service Office (ISO) approval is required, the Sprinkler Contractor shall be sure that:

1. That plans and calculations are sent for review to ISO, 100 Newport Avenue, CS1700, Quincy, MA 022690, and that all required changes are made.
2. The certificate covering materials and tests is filed with ISO.
3. That ISO has been given the proper notification, and that they are present for the 2" main drain test.
4. That the underground test certificate is filed with ISO. Coordinate with the Site Contractor.

3.11 BACKFLOW PREVENTER PERMIT AND INSTALLATION

A. All backflow prevention devices shall be approved, permitted, installed, maintained and tested in accordance with the requirements of the State and the Local Water Authority. A full size brass discharge line shall be extended to the nearest floor drain.

B. Prior to installation, the Fire Protection subcontractor shall submit through the construction manager, a design data sheet, with plans showing the method of protecting the water system, and secure approval from the Local Water Authority, or its designee. This shall not be done until the Fire Protection Subcontractor has secured the permit for the work and shop drawings have been approved.

C. Immediately upon installation, the Fire protection Subcontractor shall have the backflow preventer tested by a "Certified Backflow Prevention Device Tester", and the results recorded on the Local Water Authority's Inspection and Maintenance Report Forms. Within 14 days after the installation, the fire protection Subcontractor shall notify, through the Construction Manager, the reviewing authority to arrange inspection of the installation.

D. Three (3) copies of each application and all subsequent correspondence, including the final permit, shall be forwarded to the Designer for record. Availability of final approvals or permits shall be prerequisite to scheduling a final inspection of the fire protection work.

3.12 COMMISSIONING

A PRE-FUNCTIONAL CHECKLISTS

1. Pre-functional checklists assist in the process to document that the equipment and systems are installed properly.

2. The contractor will be provided with construction checklists from the CA for completion. The contractor shall complete the checklists as provide the CA with completed copies in accordance with 019113.

3. See attached for a sample pre-functional performance test checklist, attached is included only to provide sample of a typical process and scope.

B FUNCTIONAL PERFORMANCE TESTING

1. Intent of functional performance testing is to prove thru functional test procedures proper system operation.

2. The contractor will be provided with functional performance test procedures to perform while CA witnesses. The contractor shall perform functional tests in accordance with 019113.

3. See attached for a sample functional performance test checklist, attached is included only to provide sample of a typical process and scope.

C PREFUNCTIONAL CHECKLISTS AND FUNCTIONAL PREFORMANCE TESTING

1. Pre-Functional Checklists and Functional performance testing procedures will be performed on the following system types. (Pre Functional and Functional performance testing requirements are in addition to and do not replace any testing required elsewhere in Division 21 or by applicable codes.) Equipment specifically marked as such below shall be provided with start-up of equipment by factory-authorized service representative.

2. Fire Protection System and related equipment/accessories

D SAMPLE CHECKLISTS

1. See Attached.

Functional Test

FIRE PROTECTION SYSTEMS

1. Submittal / Approvals

Submittal. The above equipment and systems integral to them are complete and ready for functional testing. A Statement of Correction will be submitted upon completion of any outstanding areas. None of the outstanding items preclude safe and reliable functional tests being performed.

2. Prerequisite Checklist

a. All associated equipment/systems including piping and fire alarm system have been installed and are ready for functional testing.
b. All A/E punchlist items for this equipment corrected.
c. Safeties and operating ranges reviewed.
d. This checklist does not take the place of the manufacturer's recommended checkout and startup procedures.
e. This checklist does not take the place of the Authority Having Jurisdiction's (AHJ) required tests under AHJ's supervision.
f. All fire protection systems are installed per the shop drawings.
g. The Engineer of record and the Owner's insurance underwriter has approved all fire protection shop drawings including hydraulic calculations.
h. Items that do not apply shall be noted with the reasons on this form (N/A = not applicable, BO = by others).
i. Contractors assigned responsibility for sections of the checklist shall be responsible to see that checklist items by their subcontractors are completed and checked off.

3. Installation Checks

Check if Okay. Enter comment or note number if deficient.

Check	
Zone Valves	
Sealed	
Locked	
Tamper Switches	
Position	
Operation	
Supervisory	
Alarm Valves	
Pressure gauges	
Main drain/test	
Trim piping per manufacturer's instructions	
Isolation valve	
Backflow Prevention	
Reduced Pressure Backflow Preventer	
Reduced pressure Detectors Assembly	
Double Check Valve Assembly	
Double Check Detector Assembly	
Fire Department Connection	
Brass Finish	
Brass caps and chains	
Check valve	
Waterflow Alarms	

Check if Okay. Enter comment or note number if deficient.

Check	
Tied into fire alarm control panel	
Provided at alarm valve riser	
Valves, Piping	
Isolation valves installed per drawings	
Pipe fittings complete and pipes properly supported	
Pipes properly labeled	
Piping system properly flushed	
No leaking apparent around fittings	
Valves properly labeled	
Risers clamps	
Test connections	
Instrumentation installed according to specification (pressure gages, test valves.)	
Clean up of equipment completed per contract documents	
Inspectors test connections provided at all zones with equivalent sprinkler orifice size	
Maintenance access acceptable for components	

The checklist items of Part 3 are all successfully completed for given trade ☐ ***YES*** ☐ ***NO***

4. **Operational Checks**

Check if Okay. Enter comment or note number if deficient.

Check **Equip Tag➔**	**Test Results Functional Y/N**
Inspectors test valve opened flowing equivalent of one sprinkler, activation of flow switch and automatic activation of alarm at fire alarm control panel at Zone # 1	
Inspectors test valve opened flowing equivalent of one sprinkler, activation of flow switch and automatic activation of alarm at fire alarm control panel at Zone # 2	
Inspectors test valve opened flowing equivalent of one sprinkler, activation of flow switch and automatic activation of alarm at fire alarm control panel at Zone # 3	

Check if Okay. Enter comment or note number if deficient.

Check Equip Tag➔	Test Results Functional Y/N
Inspectors test valve opened flowing equivalent of one sprinkler, activation of flow switch and automatic activation of alarm at fire alarm control panel at Zone # 4	
Activation of tamper switch and automatic activation of alarm at fire alarm control panel at all valve locations	

The checklist items of Part 4 are all successfully completed for given trade ☐ ***YES*** ☐ ***NO***

END OF SECTION

SECTION 220001

PLUMBING

PART 1 – GENERAL

1.01 GENERAL PROVISIONS

A. Examine all conditions as they exist at the project, prior to submitting a bid for the work of this section.

1.02 DESCRIPTION OF WORK

A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:

1. Domestic cold water and hot water to Eyewash station.
2. Safety Eyewash Station.
3. Garage oil water waste drainage and vent system.
4. Non Potable water supply to Tank Fill station
5. Natural gas system.
6. Insulation.
7. Hangers, supports and attachments.
8. Hose Bibbs, Trap Primer, Trap Guard
9. All cutting, core drilling and channeling for plumbing equipment for holes 5” in diameter or less.
10. Fire Stopping for plumbing pipe penetration in fire rated construction.
11. Coordination drawings and record drawings and similar requirements.
12. Hoisting Equipment: The Plumbing subcontractor shall furnish, install and maintain in safe and adequate condition all mechanical hoisting equipment, operating personnel and rigging that is necessary for the proper execution of the Work of this Section.
13. Staging, Planking and Scaffolding: The Plumbing subcontractor shall furnish, install and maintain in safe and adequate condition, all staging, planking and scaffolding that is necessary for the proper execution of the Work in this Section.

B. Alternates: See Section 012300.

C. Items To Be Furnished Only: Furnish the following items for installation by the designated Sections:

1. Section 033000- CONCRETE
   a. Trench Drain
2. Section 042000 – MASONRY:
   a. Access doors in masonry openings.
   a. Section 26 00 01 - ELECTRICAL:
   a. Magnetic starters, 120/24V transformer for electronic faucets, Electric heat tracing for cooling tower make line.

D. Related Work: The following items are not included in this Section and will be performed under the designated Sections:

1. Section 03 30 00 - CONCRETE for cutting and patching of concrete walls.
2. Section 055300 METAL for Trench Drains.
3. Section 075001 – ROOFING & FLASHING for flashing of roof mounted equipment and roofing penetrations.
4. Section 078446 – FIRE RESISTIVE JOINT SYSTEMS
5. Section 210001- FIRE PROTECTION : Sprinkler Drains
6. Section 230001 – HEATING, VENTILATING AND AIR CONDITIONING for coordination with HVAC piping and ductwork and for condensate drains.
7. Section 31 20 00 – EARTH WORK for excavation and backfilling.

E. Perform work and provide material and equipment as shown on Drawings and as specified or indicated in this Section of the Specifications. Completely coordinate work of this Section with work of other trades and provide a complete and fully functional installation.

F. Drawings and Specifications form complimentary requirements; provide work specified and not shown, and work shown and not specified as though explicitly required by both. Although work is not specifically shown or specified, provide supplementary or miscellaneous items, appurtenances, devices and materials obviously necessary for a sound, secure and complete installation.

G. Give notices, file plans, obtain permits and licenses, pay fees and back charges, and obtain necessary approvals from authorities that have jurisdiction as required to perform work in accordance with all legal requirements and with Specifications, Drawings, Addenda and Change Orders, all of which are part of Contract Documents.

1.03 SUBMITTALS

A. Comply with requirements specified in Section 013300 – SUBMITTALS.

B. Material and equipment requiring Shop Drawing Submittals shall include but not be limited to:

1. Eye Wash Station.
2. Hose bibbs and wall hydrants.
3. Gas valve, pressure regulation valve
4. Trench Drain
5. Piping, Fittings, unions, flanges, and couplings.
6. Insulation.
7. No-hub couplings.
8. Hangers, plates, and inserts.
9. Vibration isolation and flexible connections.

1.04 DEFINITIONS

A. As used in this Section, "provide" means "furnish and install" and "POS" means "Provided Under Other Sections". "Furnish" means "to purchase and deliver to the

project site complete with every necessary appurtenance and support," and "Install" means "to unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project."

1.05 CONTRACT DOCUMENTS

A. Listing of Drawings does not limit responsibility of determining full extent of work required by Contract Documents. Refer to Architectural, HVAC, Plumbing, Fire Protection, Electrical, Structural, and other Drawings and other Sections that indicate types of construction in which work shall be installed and work of other trades with which work of this Section must be coordinated.

B. Except where modified by a specific notation to the contrary, it shall be understood that the indication and/or description of any item, in the drawings or specifications or both, carries with it the instruction to furnish and install the item, regardless of whether or not this instruction is explicitly stated as part of the indication or description.

C. Items referred to in singular number in Contract Documents shall be provided in quantities necessary to complete work.

D. Drawings are diagrammatic. They are not intended to be absolutely precise; they are not intended to specify or to show every offset, fitting, and component. The purpose of the drawings is to indicate a systems concept, the main components of the systems, and the approximate geometrical relationships. Based on the systems concept, the main components, and the approximate geometrical relationships, the contractor shall provide all other components and materials necessary to make the systems fully complete and operational.

E. Information and components shown on riser diagrams but not shown on plans, and vice versa, shall apply or be provided as if expressly required on both.

F. Data that may be furnished electronically by the Designer (on computer tape, diskette, or otherwise) is diagrammatic. Such electronically furnished information is subject to the same limitation of precision as heretofore described. If furnished, such data is for convenience and generalized reference, and shall not substitute for Designer's sealed or stamped construction documents.

1.06 DISCREPANCIES IN DOCUMENTS

A. Where Drawings or Specifications conflict or are unclear, advise Designer in writing before Award of Contract. Otherwise, Designer's interpretation of Contract Documents shall be final, and no additional compensation shall be permitted due to discrepancies or un clarities thus resolved.

B. Where Drawings or Specifications do not coincide with manufacturers' recommendations, or with applicable codes and standards, alert Designer in writing before installation. Otherwise, make changes in installed work as Designer requires within Contract Price.

C. If the required material, installation, or work can be interpreted differently from drawing to drawing, or between drawings and specs, this contractor shall provide that material, installation, or work which is of the higher standard.

D. It is the intent of these contract documents to have the contractor provide systems and components that are fully complete and operational and fully suitable for the intended use. There may be situations in the documents where insufficient information exists to precisely describe a certain component or subsystem, or the routing of a component. In cases such as this, where the contractor has failed to notify the Designer of the situation in accordance with Paragraph (A) above, the contractor shall provide the specific component or subsystem with all parts necessary for the intended use, fully complete and operational, and installed in workmanlike manner either concealed or exposed per the design intent.

E. In cases covered by Paragraph (D) above, where the contractor believes he needs engineering guidance, he shall submit a sketch identifying his proposed solution and the Designer shall review, note if necessary, and approve the sketch.

1.07 MODIFICATIONS IN LAYOUT

A. Plumbing Drawings are diagrammatic. They indicate general arrangements of mechanical and electrical systems and other work. They do not show all offsets required for coordination nor do they show the exact routings and locations needed to coordinate with structure and other trades and to meet Architectural requirements.

B. In all spaces, prior to installation of visible material and equipment, including access panels, review Architectural Drawings for exact locations and where not definitely indicated, request information from Designer.

C. Check Contract Drawings as well as Shop Drawings of all subcontractors to verify and coordinate spaces in which work of this Section will be installed.

D. Maintain maximum headroom at all locations. All piping and associated components to be as tight to underside of structure as possible.

E. Where conflicts or potential conflicts exist and engineering guidance is desired, submit sketch of proposed resolution to Designer for review and approval.

1.08 SITE VISIT

A. Before submitting bid, visit and carefully examine site to identify existing conditions and difficulties that will affect work of this Section. No extra payment will be allowed for additional work caused by unfamiliarity with site conditions that are visible or readily construed by experienced observer.

1.09 EXISTING CONDITIONS AND PREPARATORY WORK

A. Before starting work in a particular area of the project, visit site and examine conditions under which work must be performed including preparatory work done under other

Sections or Contracts or by the Owner. Report conditions that might affect work adversely in writing through General Contractor to Designer. Do not proceed with work until defects have been corrected and conditions are satisfactory. Commencement of work shall be construed as complete acceptance of existing conditions and preparatory work.

1.10 CODES, STANDARDS, AUTHORITIES AND PERMITS

A. Perform work strictly as required by rules, regulations, standards, codes, ordinances, and laws of local, state, and Federal governments, and other authorities that have legal jurisdiction over the site. Materials and equipment shall be manufactured, installed and tested as specified in latest editions of applicable publications, standards, rulings and determinations of:

1. Local and state building, plumbing, fuel gas mechanical, electrical, fire and health department codes.
2. American Gas Association (AGA).
3. National Fire Protection Association (NFPA).
4. American Insurance Association (A.I.A.) (formerly National Board of Fire Underwriters).
5. Occupational Safety and Health Act (OSHA).
6. Factory Mutual Association (FM).
7. Underwriters' Laboratories (UL).
8. American National Standards Institute (ANSI).

B. Material and equipment shall be listed by Underwriters' Laboratories (UL), and approved by ASME and AGA for intended service.

C. Plumbing Fixtures and Potable water shall meet both the NSF 61, lead free and NSF 372 test standards via third-party testing and certification.

D. When requirements cited in this Specification conflict with each other or with Contract Documents, most stringent shall govern work. Designer may relax this requirement when such relaxation does not violate ruling of authorities that have jurisdiction. Approval for such relaxation shall be obtained in writing.

E. Most recent editions of applicable specifications and publications of the following organizations form part of Contract Documents:

1. American National Standards Institute (ANSI).
2. American Society of Mechanical Engineers (ASME).
3. National Electric Manufacturers Association (NEMA).
4. American Society for Testing and Materials (ASTM).
5. American Water Works Association (AWWA).
6. Thermal Insulation Manufacturers Association (TIMA).
7. Institute of Electrical and Electronics Engineers (IEEE).
8. Insulated Cable Engineers Association (ICEA).
9. National Fire Protection Association (NFPA).

1.11 GUARANTEE AND 24 HOUR SERVICE

A. Guarantee Work of this Section in writing for one year following the date of beneficial occupancy by the User Agency. If the equipment is used for ventilation, temporary heat, etc. prior to initial beneficial occupancy by the User Agency, the bid price shall include an extended period of warranty covering the one-year of occupancy, starting from the initial date of beneficial occupancy by the User Agency. The guarantee shall repair or replace defective materials, equipment, workmanship and installation that develop within this period, promptly and to Designer's satisfaction and correct damage caused in making necessary repairs and replacements under guarantee within Contract Price.

B. In addition to guarantee requirements of Division 01 and of Paragraph A above, obtain written equipment and material warranties offered in manufacturer's published data without exclusion or limitation, in User Agency's name.

C. Replace material and equipment that require excessive service during guarantee period as defined and as directed by Designer.

D. Provide 24 hour service beginning on the date the project is first beneficially occupied by the User Agency, whether or not fully occupied, and lasting until the termination of the guarantee period. Service shall be at no cost to the owner. Service can be provided by this contractor or a separate service organization. Choice of service organization shall be subject to Designer and Project Manager approval. Submit name and a phone number that will be answered on a 24-hour basis each day of the week, for the duration of the service.

E. Submit copies of equipment and material warranties to Designer before final payment.

F. At end of guarantee period, transfer manufacturers' equipment and material warranties still in force to User Agency.

G. Use of systems provided under this Section for temporary services and facilities shall not constitute Final Acceptance of work nor beneficial use by User Agency, and shall not institute guarantee period.

H. Provide manufacturer's engineering and technical staff at site to analyze and rectify problems that develop during guarantee period immediately. If problems cannot be rectified immediately, advise Designer in writing, describe efforts to rectify situation, and provide analysis of cause of problem. Designer will suggest course of action.

1.12 RECORD DRAWINGS

A. Comply with requirements specified in Section 017839 – PROJECT RECORD DOCUMENTS and Section 017700-Project Closeout.
B. Drawings shall show record condition of details, sections, riser diagrams, control changes and corrections to schedules. Schedules shall show actual manufacturer and make and model numbers of final equipment installation.

1.13 BULLETINS, MANUALS, AND OPERATING INSTRUCTIONS, AND PROTECTION

A. Obtain at time of purchase of equipment, three copies of operation, lubrication and maintenance manuals for all items. Assemble literature in coordinated manuals with additional information describing combined operation of field-assembled units, including as-built wiring diagrams. Manual shall contain names and addresses of manufacturers and local representatives who stock or furnish repair parts for items or equipment. Divide manuals into three sections or books as follows:

1. Directions for and sequence of operation of each item of Plumbing systems. Sequence shall list valves, switches, and other devices used to start, stop and control system. Include approved valve directory showing each valve number, location of each valve, and equipment or fixture controlled by valve.

2. Detailed maintenance and trouble shooting manuals containing data furnished by manufacturer for complete maintenance. Include copy of balancing report.

3. Lubrication instructions detailing type of lubricant, amount, and intervals recommended by manufacturer for each item of equipment. Include additional instructions necessary for implementation of first class lubrication program. Include approved summary of lubrication instructions in chart form, where appropriate.

B. Furnish three copies of manuals to Designer for approval and distribution to owner. Deliver manuals no less than 30 days prior to acceptance of equipment to permit User Agency's personnel to become familiar with equipment and operation prior to acceptance.

C. Provide framed and glazed charts as follows: mount as directed by Designer.

1. Flow diagrams from first part of manual as described above.
2. Valve directory.
3. Lubrication chart from third part of manual.

D. Operating instructions: Upon completion of installation or when Project Manager accepts portions of building and equipment for operational use, instruct User Agency's operating personnel in any or all parts of various systems. Instructions shall be performed by factory-trained personnel. User Agency shall determine which systems require additional instructions. Duration of instructions shall take equipment through complete cycle of operation (at least five working days). Make adjustments under operating conditions. This subcontractor shall videotape all instructions given to the owner, and shall provide up the three hours of videotape instructions. Three copies of the videotaped instructions shall be submitted by the owner.

E. Each contractor shall be responsible for his work and equipment until finally inspected, tested, and accepted. Carefully store materials and equipment which are not immediately installed after delivery to site. Close open ends of work with temporary covers or plug during construction to prevent entry of obstructing material.

F. Each separate contractor shall protect the work and material of other trades that might be damaged by his work or workmen and make good all damage thus caused.

1.14 COORDINATION DRAWINGS

A. This plumbing sub contractor shall prepare coordination drawings clearly showing how his work is to be installed in relation to the other trades such as HVAC, Electrical, Fire Protection and including sections and details, as required under Section 013300 – SUBMITTALS.

1.15 LOCATION OF FIXTURES AND EQUIPMENT

A. The Architect will establish the exact location of all fixtures, equipment, and devices to be located in finished spaces of the building. Such precise locations are, for the most part, indicated on the Architectural Plans of the various spaces, and it shall be the responsibility of this SECTION 22 00 01 Subcontractor to obtain instructions from the Architect for the location of any items whose location is not specifically given on the Architectural Drawings. Any work installed contrary to the Architectural Drawings, or without the prior approval of the Architect, shall be relocated and any necessary changing or patching of the surrounding work shall be done at the expense of this SECTION 220001 Subcontractor.

1.19 CEILING MARKER SYSTEM

A. At all valves located above ceilings of any type, ceilings shall be marked with tacks firmly attached to the ceiling surface. Tacks shall be part of a complete system, Brady Co. *Valve Finder Ceiling Tacks* or approved equal product from Westline Products or Seton Name Plate Co.

PART 2 - PRODUCTS

2.00 PIPE, FITTINGS AND JOINTS

A. General

1. Pipe and fittings shall conform to the latest ANSI, ASTM, NFPA and AWWA Standards including latest amendments.

2. Each length of pipe, each pipe fitting, trap, material and/or device used in the respective system shall have cast, stamped or indelibly marked on it, the maker's name or mark, weight and quality of the product when such marking is required by the approved standard that applies.

3. Piping and fittings shall be factory coated.

B. Sanitary Drainage Piping Above Floor (Oil water waste and Vent)

1. Piping 2" and larger shall be no-hub service weight cast iron soil pipe. The pipe shall be legibly marked on the barrel with the manufacturer's name and/or trademark.

2. All cast iron soil pipe and fittings shall conform to the requirements of CISPI Standard 301, ASTM A 888 or ASTM A 74 for all pipe and fittings. Pipe and fittings shall be marked with the collective trademark of the CastIron Soil Pipe Institute or receive prior approval of the engineer. Latest issue of each standard shall apply.

3. Sanitary piping 2” and smaller shall be type “L” copper.

4. Couplings for joining no-hub cast iron soil pipe: Couplings shall have a shield constructed of corrugated 304 stainless steel and provide a shield thickness of 0.16 inches or greater. Shield shall be a minimum width of 3 inches, for pipe sizes 1-1/2 inch through 4 inch, and a minimum width of 4 inches, for pipe sizes 5 inch through 10 inches. Couplings with at least 4 sealing bands shall require 80 inch pounds of torque per band. Tightening screws shall be 3/8 inch hexagon head. Couplings with only 2 sealing bands on sizes 1-1/2 inch through 4 inches shall require 125 inch pound of torque per band. Gaskets shall be neoprene rubber conforming to ASTM C-564. No Hub coupling shall be Tested and Certified to NSF, CISPI 310, ASTM 1277.

5. Joints in copper tubing except as otherwise specified herein shall be made according to manufacturer's specifications using sweat fitting and lead free solder and non-corrosive flux.

6. Connections between earthenware of any fixture and flanges in soil and waste piping shall be made absolutely gas and watertight with closet setting

compounds and gaskets which must be absolutely gas and fireproof, watertight, stain proof, containing neither oil nor asphaltum and which will not rot, harden or dry under any extreme climatic change, and must adhere on wet surfaces.

C. Sanitary Drainage Piping Below Floor (Oil Water Waste and Vent)

1. Piping below floor shall be service weight cast iron hub and spigot.

2. Joints in cast iron soil piping below ground shall be code approved compression type, made with rubber gaskets conforming to ASTM Specification C564. Joints in cast iron soil pipe and fittings using a double seal, compression type molded neoprene gasket shall be provided with a modified hub as required to provide a positive seal. No-hub pipe will not be allowed below ground. (Adhesive type lubricant shall be used with the resilient gaskets on pipes 5" and larger).

D. Water Piping (For Domestic Cold and Hot water)

1. Buried Water Piping

a. Under-building-slab and exterior buried piping shall be copper tube, Type K with wrought-copper solder-joint fittings; and brazed joints.

2. Above Ground

a. 2-1/2 inches and smaller shall be hard drawn Type L copper with wrought or cast copper fittings.

b. 3 inches and larger may be hard drawn Type L copper with roll grooved mechanical couplings.

c. Joints in copper tubing except as otherwise specified herein shall be made according to manufacturer's specifications using sweat fitting and lead free solder and non-corrosive flux.

d. Provide galvanized malleable iron unions, with bronze facings conforming to ANSI B16.39 for sizes 2 inch and smaller.

e. Provide copper flanges conforming to ANSI B16.5, standard or welding neck pattern.

E. Natural Gas and Gas Relief Vents

1. 2 inches and smaller shall be Schedule 40 black steel pipe with malleable iron threaded cast fittings ASTM B16.3, Class 150.

2. 2-1/2 inches and larger shall be schedule 40 black steel pipe in accordance with ASTM A.53 with butt welding fittings in accordance with ANSI B16.9, ANSI /ASME 36.10.

3. Gas piping at equipment shall be provided with additional supports.

4. Facility will have two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

5. All work shall be installed in strict accordance with the State Gas Code.

6. Welders Qualifications (Natural Gas System): Qualifications of the procedure and of the welding operations and welders shall be as specified in American Welding Society, AWS D10.9-80, "Specification for Qualification of Welding Procedures and Welders for Pipe and Tubing"; ANSI B31.1 and ASME Boiler Code, Section 1X.

7. The sub-contractor shall provide certification in writing that the operator or welder has met the above prescribed standard. The owner's project manager reserves the right to employ testing agencies to test welds. Where results demonstrate deficiencies in the work, the contractor shall take all action necessary to correct the work in a timely manner at their own expense. When the sub-contractor considers the work to be corrected, further tests minimum 5% of welds will be performed by the owner's project manager at the sub-contractor's expense.

F. Unions and Flanges

1. Unless otherwise specified herein, unions for copper and brass piping two inches and smaller in diameter shall be 125 SWP, bronze body brass ground joint type. Those larger than two inches in diameter shall be 150 SWP flat faced cast brass flanges conforming to ANSI Standard B16.24.
2. Where brass flanges and ferrous flanges are to be joined, ferrous flanges shall be full faced.

3. Mating of ferrous and non-ferrous flanges shall be separated with rubber gaskets (1/16 inch minimum thickness) and teflon liners installed in the bolt holes. Bolt holes shall be drilled to receive the teflon lines. Physical contact between the ferrous and non-ferrous flanges including the bolts, nuts and washers will not be permitted.

4. Unions for ferrous piping shall be of the same material as the piping to which they connect.

2.01 VALVES AND SUNDRIES

A. General

1. Manufacturer: Subject to compliance with requirements, provide products from one of the manufacturers listed. Nibco, Watts, Apollo or approved equal.
2. Valve Design: Rising stem or rising outside screw and yoke stems.

3. Nonrising stem valves may be used where headroom prevents full extension of rising stems.
4. Pressure and Temperature Ratings: As scheduled and required to suit system pressures and temperatures.
5. Sizes: Same size as upstream pipe, unless otherwise indicated.
6. Operators: Provide the following special operator features:

    a. Handwheels, fastened to valve stem, for valves other than quarter turn.
    b. Lever handles, on quarter turn valves 6 inch and smaller, except for plug valves. Provide plug valves with square heads; provide one wrench for every 10 plug valves.
7. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.

8. Bypass and Drain Connections: Comply with MSS SP-45 bypass and drain connections.

9. End Connections: As indicated in the valve specifications.
    a. Threads: Comply with ANSI B1.20.1.
    b. Flanges: Comply with ANSI B15.1 for cast iron, ANSI B16.5 for steel, and ANSI B16.24 for bronze valves.
    c. Solder-Joint: Comply with ANSI B16.18.

        1) Caution: Where soldered end connections are used, use solder having a melting point below 840 deg. F for gate, globe, and check valves; below 421 deg F for ball valves.

B. Valves in the interior domestic water piping systems (cold water, hot water) and gas system:

1. Acceptable Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, Nibco, Watts, Apollo, or approved equal.

2. Ball Valves

    a. Ball Valves, 1 Inch and Smaller: Rated for 400 psi WOG pressure; two piece construction; with bronze body conforming to ASTM B 62, standard (or regular(port, chrome-plated brass ball, replaceable “Teflon” or “TFE” seats and seals, blowout-proof stem, and vinyl covered steel handle. Provide solder ends for domestic hot and cold water service.

    b. Ball Valves, 1-1/4 Inch to 2 Inch: Rated for 400 psi WOG pressure; 3 piece construction; with bronze body conforming to ASTM B 62, conventional port, chrome-plated brass ball, replaceable “Teflon” or “TFE” seats and seals, blowout-proof stem, and vinyl covered steel handle. Provide solder ends for domestic hot and cold water service.

3. Butterfly Valves

a. Butterfly Valves, 2-1/2 Inch and Larger: MSS SP-67; rated at 200 psi; cast iron body conforming to ASTM A 126, Class B. Provide valves with field replaceable EPDM sleeve, nickel-plated ductile iron disc (except aluminum bronze disc for valves installed in condenser water piping), stainless steel stem, and EPDM O ring stem seals. Provide lever operators with locks for sizes 2 through 6 inches and gear operators with position indicator for sizes 8 through 24 inches. Provide lug or wafer type as indicated. Drill and tap valves on dead end service or requiring additional body strength.

4. Check Valves

a. Swing Check Valves, 2 Inch and Smaller: MSS SP-80; Class 125, cast bronze body and cap conforming to ASTM B 62; with horizontal swing, Y pattern, and bronze disc; and having threaded or solder ends. Provide valves capable of being reground while the valve remains in the line. Provide Class 150 valves meeting the above specifications, with threaded end connections, where system pressure requires or where Class 125 valves are not available.

b. Swing Check Valves, 2-1/2 Inch and Larger: MSS SP-71; Class 125 (Class 175 FM approved for fire protection ping systems), cast iron body and bolted cap conforming to ASTM A 126, Class B; horizontal swing, and bronze disc or cast iron disc with bronze disc ring; and flanged ends. Provide valves capable of being refitted while the valve remains in the line.

C. Gas Valves Interior

1. Ball Valves: Ball valves shall be the fire seal type, conforming to UL 842 and UL 125.
2. Valves shall be rated for service at not less than 200 psi at 200 degrees F.
3. Valve bodies in sizes 1 inch ips and smaller shall be screwed end type constructed of ductile iron, carbon steel, or cast steel.
4. Valve bodies in sizes 2 inch ips and larger shall be flanged end type constructed of ductile iron, carbon steel, or cast steel unless otherwise specified
5. Valve bodies shall have socket weld ends or butt weld ends where indicated to be welded, and body shall be constructed of carbon steel or cast steel.
6. Balls and stems shall be Type 316 corrosion resistant steel.
7. Valves shall be suitable for flow from either direction and shall seal tightly in either direction.
8. Valves shall have full pipe size flow areas where indicated.
9. Valve seats and seals shall be tetrafluoroethylene; seats shall have secondary corrosion resistant steel seating surfaces to effect shutoff should resin be burned out.

10. Gauge Cocks: Gauge cocks shall be T head or lever handle ground key type with washer and screw, constructed of polished ASTM B 62 bronze, 125 psi. End connections shall suit the service, with or without union and nipple.
11. Eccentric Plug Valves: Eccentric plug valve maximum size shall be limited to 3 inch ips.
12. Eccentric plug valves shall be constructed with semi-steel body, bronze plug with Buna N resilient elastomer seals. Body sealing face shall be plastic coated.
13. Body end connection shall be screwed for sizes 1 inch ips and smaller and flanged in sizes through 3 inch ips.
14. Plug shall be top and bottom guided by oil impregnated bronze bushings and shall be corrosion resistant steel spring loaded.
15. Valves shall be rated at 175 psi WOG and shall be UL listed for natural gas service.
16. Lubricated Plug Valves: Valves shall be Type 1, Style A or B, taper plug type, rated for not less than 175 psi WOG service and shall conform to MIL V 12003.
17. Valves may be cylindrical plug type, constructed to service pressure and materials requirements specified for taper plug valves; in addition, clearance between plug and body sealing surfaces shall not exceed 2 mils for valves to 2 inch ips and shall be 3 to 5 mils for larger valves; plug stem seal and bottom support shall be reinforced tetrafluoroethylene; plug shall be bottom spring loaded.
18. Plug shall be full port or restricted port type, unless otherwise indicated.
19. Regulator bypass valves shall be provided with proportioning ports and locking feature.
20. Valves shall be provided with screwed end connections for all sizes 1 inch ips and smaller and flanged end connections for all larger valves.
21. Check valve type lubrication fittings shall be provided for grease gun lubrication. Lubricant shall be identified and sufficient quantity shall be provided to lubricate each valve at least once.
22. Gas Line Pressure Regulators: ANSI Z21.80/CSA 6.22 standard, Single stage,class 2, steel jacketed, corrosion-resistant gas pressure regulators; with atmospheric vent, elevation compensator; with threaded ends for 2 inch and smaller, flanged ends for 2-1/2 inch and larger; for inlet and outlet gas pressures and volume flow indicated. Coordinate requirement for indoor and outdoor installation per the manufacturers instruction. The regulator shall be equal to Maxitrol Co, Fisher Controls, National Meter Industries or equal.

D. Sundries

1. Acceptable Manufacturers: Chicago Faucet, Watts, T & S Brass and Bronze Works, Inc., Speakman Co., Josam Manufacturing, Jay R. Smith, Precision Plumbing Products or approved equal.
2. Vacuum breakers shall be full size of line feed. All hose bibbs shall be supplied with vacuum breakers attached to hose thread portion of hose bibb unless they are integral to fixture.
3. Hose Bibbs shall be equal to the following:

    a. HB-1 (as indicated on plan) Full flow in-line vacuum breaker with hose thread outlet, 2” vandal proof handle, slow compression operating

catridge and ¾" NPT female inlet. Equal to Chicago No. 387-E27-369COLDCP. Josam, Watts.
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2.02 VENTS THROUGH ROOF

A. All pipes extending through the roof for the sanitary system shall be the same material as the piping system. Vents shall be of size indicated on the Drawings and extend at least 24 inches above the roof, ending in the top of pipe, which will be flashed by the Roofing Contractor, for the respective roofing systems.
B. All vent piping shall be terminated 25 feet away from any HVAC unit intake.
C. All vent piping within 25 feet from any HVAC intake or as indicated on the drawing must be extended higher and terminate two feet above the maximum height of the air intake.
D. Vent Terminal Extensions shall be hubless cast iron piping.

2.03 HANGERS AND ACCESSORIES

A. General
1. Provide pipe stands, supports, hangers and other supporting appliances as necessary to support work required by Contract Documents. All components of the hanger support system shall comply with the standards set forth in MSS-SP58 and MSS-SP69 (Manufacturers Standardization Society) latest publication.

2. Manufacturers: Subject to compliance with requirements, provide hangers and supports of Carpenter and Patterson, Inc, ITT Grinnel Corp., Elecen Metal Products or approved equal.

B. Secure vertical piping to building construction to prevent sagging or swinging.
C. Space hangers for horizontal piping as follows:

Pipe Size	Rod Diameter	Maximum Spacing
½" and ¾"	3/8"	6 ft-0"
1" and 1-1/4"	3/8"	8 ft.-0"
1-1/2 and 2"	3/8"	10 ft.-0"
2-1/2 and 3"	1/2"	10 ft.-0"
4 and 5"	5/8"	12 ft.-0"
6 in.	3/4 in.	12 ft.-0 in.
8 in and over.	7/8 in.	12 ft.-0 in.

D. Friction clamps shall be equal to Figures 126 and copper plated when in direct contact with copper or brass piping.
E. Hangers for uncovered (uninsulated) copper or brass piping 2" and smaller shall be Carpenter & Patterson Figure 1ACT steel, copper plated band type.
F. Hangers for uncovered (uninsulated) steel or cast iron piping 2" and smaller shall be Carpenter & Patterson Figure 1A steel band type.
G. Hangers for uncovered (uninsulated) steel or cast iron piping 2-1/2” and larger shall be Carpenter & Patterson Figure 100 steel clevis type.
H. Hangers for all insulated piping shall be Carpenter & Patterson Figure 100 steel clevis type with insulation shield specified below.
I. Hangers for uncovered (uninsulated) copper or brass piping 2-1/2” and larger shall be factory applied copper plated steel clevis hangers, Carpenter & Patterson Fig. 100 CT. Rods and nuts used with these hangers shall also be factory applied copper plated.
J. Where three or more pipes are running parallel to each other, factory fabricated gang type hangers with pipe saddle clips, or rollers may be used in lieu of the hereinbefore specified Clevis hangers. These hangers shall be sized to provide for insulation protectors as hereinafter specified. Pipe saddle clips shall be not less than 16 gauge metal and shall be copper when installed with uninsulated copper piping. Where pipe rollers are provided for uninsulated copper or brass piping, insulation protectors shall be provided at each set of rollers and filled with a section of heavy density fiberglass pipe covering specified hereinafter. (Refer to insulation of this specification.) Fig. 342 sized to suit loading with hanger rods and nuts.
K. Extension type split ring hangers with wall plates shall be equal to Carpenter & Patterson Figures 81, 81-CT, 90-CT and 85, 85-CT plates for iron, steel and copper.
L. Hanger rods for other installations shall be sized in accordance with the recommended load capacities of ASTM Specifications Designation A-107, latest amendment.
M. Insulation protectors (shields) for horizontal piping shall be constructed of galvanized steel formed to a 180 degree arc and 12 inches long, equal to Carpenter & Patterson Figure 265P, 18 gauge type H for hangers 5 inches in size and smaller, 16 gauge for hangers larger than 5 inches in size.
N. Exposed rods, clamps and hangers shall be electrogalvanized coated.
O. Installation of hangers which permit wide lateral motions of any pipe will not be acceptable.
P. "C" clamps installed with pipe hangers or equipment hangers will not be permitted unless provided with retaining straps.
Q. All no-hub cast iron pipe 6 inches or larger in diameter shall be braced to prevent horizontal movement as required by code and recommended by the Cast Iron Soil Pipe Institute by using braces, blocking or rodding as illustrated in the CISPI Handbook, Vol. II, Specification Section 310-78.
R. All gas piping 2 in. and larger shall have bracing. Refer to NFPA 13 for methods and procedures.

2.04 INSERTS AND ESCUTCHEONS

A. Inserts shall be individual or strip type of pressed steel construction with accommodation for removable nuts and threaded rods up to 3/4 inch diameter, permitting lateral adjustment. Individual inserts shall have an opening at the top to allow reinforcing rods up to 2 inch diameter to be passed through the insert body. Strip inserts shall have attached rods with hooked ends to allow fastening to reinforcing rods.

B. Unless otherwise specified herein, escutcheons shall be cast brass chrome plated type and provided with a set screw to properly hold escutcheon in place.

2.05 PIPE COVERING (INSULATION)

A. General

1. The pipe covering specified herein for piping system shall be provided to strict accordance with the manufacturer's printed instructions, the best practice of the trade and to the full intent of this Specification.

2. Flame/Smoke Ratings: Provide complete fibrous glass pipe insulation (insulation, jackets, coverings, sealers, mastics and adhesives) with flame spread index of 25 or less, and smoke developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.

3. Manufacturer: Subject to compliance with requirements, provide products of Johns Manville "Micro-Lok HP", Knauf Fiber-Glass, Owens Corning or approved equal.

4. Apply insulation after systems have been tested, proved tight and approved by Designer. Remove dirt, scale, oil, rust and foreign matter prior to installation of insulation.

5. No leaks in vapor barrier or voids in insulation will be accepted.

6. Insulation and vapor barrier on piping which passes through walls or partitions shall pass continuously through sleeve, except that piping between floors and through fire walls or smoke partitions shall have space allowed for application of approved packing between sleeves and ping, to provide fire stop as required by NFPA. Seal ends to provide continuous vapor barrier where insulation is interrupted.

B. Insulation:

1. Interior Cold and Hot Water Recirculation pipe
   a. 1" insulation for all pipe sizes.
   b. ASTM E-547, Class I

2. Hot Water Supply.

   a. 1" thick insulation for pipe sizes less than pipe size 1.5" and 1.5" thick insulation for pipe sizes equal and greater than pipe size 1.5".
   b. ASTM E-547, Class I

3. Fire retardant foil face jackets for ping insulation: ASTM C-921, Type I for piping with temperatures below ambient, Type II for piping with temperatures above ambient. Type I may be used for all piping at installation option.

4. Encase piping fittings insulation with one piece premolded PVC fitting covers, fastened as per manufacturer's recommendations.

5. Encase exterior piping insulation with aluminum jacket with weatherproof construction.

6. Insulate and provide weatherproof jacket for cooling tower make up water line at roof level with 2" insulation.

7. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for applications indicated.

8. Provide product document submittals according to the LEEDv4-S rating system. The product must achieve IEQ Credit 2 Low emitting Materials rating requirement.

2.06 CLEANOUTS

A. Cleanouts shall be Jay R. Smith, Josam, MIFAB or approved equal.

B. Bodies of cleanout in hub and spigot or no-hub piping shall be standard pipe size conforming in thickness to that required for pipe and fittings, and shall extend not less than 3/4 inch above the hub of the pipe. The cleanout plug shall be of cast brass and shall be provided with a raised nut 3/4 inch high. Cleanouts in threaded waste piping shall be cast iron drainage "T" pattern 90 degree branch fittings with extra heavy brass screw plugs of the same size as the pipe.

C. Floor cleanouts shall be as follows:

1. CO: Wall cleanout with cast bronze cleanout plug, round smoth stainless steel cover. The cleanout shall be equal to MiFAB C1430-RD-BA.
2. FCO: Bus Maintenance and Storage area shall have Extra Heavy duty cleanouts with D.C.C.I w/ Polished Stainless steel extra heavy duty top, solid gasket cover, equal to ZURN Z1400-ZS-SG-HD

2.07 TRENCH DRAIN

A. Trench drain to be 20' long (see plan for overall length) with bottom outlet at the center. The trench type to be equal to MIFAB Series T1330-FL-FAB. Other manufacturers are Zurn, Jay R smith or equal. Trench drain body shall be 10" internal wide, 40" long pre-sloped (1/8" per foot) modular trench drain. Body is manufactured from 14 gauge steel and finished with an acid resistant powder epoxy coating. Each body has a 3" wide anchor flange on each side recessed 2 3/4" down from the top. Bodies have flanged ends to connect to each other with a neoprene rubber gasket in between. Bottom outlets in 4" no hub outlet connections and shall be fabricated as part of the trench drain system. 20" long, Class H-20 ductile iron grates along with grate lockdown hardware for each grate to secure to the body.

2.08 PLUMBING FIXTURES

A. Plumbing Fixtures

1. Acceptable Manufacturers: Submit manufacturers not listed below for review and approval as specified for substitutions in this Section.

    a. Thermostatic Mixing Valves: Leonard Valve Co., Powers Process Controls, Symmons, Chicago Faucets or equal.
    b. Catch Basin: MiFab, Watts, Jay R Smith or equal
    c. P-Traps: McGuire, Sanitary-Dash, or Jameco.
    d. Emergency eye wash/ shower : Guardian, Speakman, Haws or equal.

B. Fixture Description

1. P-1: Pedestal mounted eyewash with ABS plastic bowl, Schedule 40 galvanized pipe and fittings, ½" U.S. made chrome-plated stay-open ball valve, powder-coated cast aluminum flag handle and floor flange. Unit shall have (2) polypropylene GS-Plus™ spray heads with integral "flip-top" dust covers, filters and 1.6 GPM flow control orifices mounted on a chrome-plated brass eyewash assembly. Unit shall include Thermostatic Mixing Valve (TM2A) as specified in 2.18 paragraph. ANSI compliant sign. Unit shall be hydrostatically tested to meet or exceed ANSI Z358.1 – 2014. Product shall be equal to Guardian Equipment G1825P.

2.09 THERMOSTATIC MIXING VALVE

A. General
Thermostatic mixing valve shall be as manufactured by Symmons, Ind., Leonard, Powers or approved equal.

B. Furnish upon completion of all work, certificates of inspections from the manufacturers stating that authorized factory engineers have inspected and tested the operation of their respective equipment and found same to be in satisfactory operating conditions.

C. Thermostatic mixing valve for individual Emergency Eye Wash (TM1). The mixing valve shall ASSE 1071 certified and meet ANSI Z358.1-2009 requirement. The valve shall be equal to Guardian G3600LF furnish in stainless steel cabinet and lockable latch. The valve shall be directly linked to control the hot and cold water intake and blend to deliver tepid water (75F adjustable). The valve shall be capable of supplying 2 to 6 gpm of tepid water at maximum 20 psi pressure drop. In event of restriction or failure of hot water supply, internal bypass shall allow valve to deliver cold water to emergency unit. In bypass mode, valve shall deliver 4 gpm at 30 psi drop. In event of loss of cold water supply, valve shall close and shall not deliver water

2.10 TRAP SEAL GUARD

A. Protect all outlet connection of Catch Basins and Trench Drains with inline trap seal guard. The trap seal shall prevent odors, sewer gases to escape from p-trap. The trap seal shall be flexible silicone sealing ribs to stay in closed position and allow only drainage flows. The trap seal guard shall be equal to MiFAB Mi-Gard. Other acceptable manufactures are SureSeal, Jay R Smith.

2.11 FIRE STOPPING

A. Seal openings of fire rated construction with a material or product to the standard described on specification section 078413 Penetrating Firestoppong.

B. Smoke proof and Seal all plumbing pipe penetration in corridor wall regardless it is rated or unrated wall construction.

C. Refer to specification section 078413 Penetrating Firestopping

2.12 SLEEVES AND PENETRATIONS

A. Piping penetrations through fire rated construction shall comply with a listed fire rated assembly as detailed in the UL Fire Resistance Directory. Pipe sleeves through floors, exterior walls and fire-rated construction shall be galvanized Schedule 40 steel pipe. Pipe sleeves through non-fire-rated partitions shall be 26 gauge galvanized steel.

1. Sleeves Through Exterior Below Grade Foundation Walls and Floor Slabs on Grade: Provide galvanized Schedule 40 steel with continuous weld slop on welding flange water stop. Provide waterproof caulking assembly by Link-Seal or Sure-Seal.

2. In areas where pipe is exposed, install sleeves flush with the finish floor, except in mechanical rooms, and janitor's closets extend sleeves at least 4 inches above finish floor.

3. Annular Space Requirements: Sleeves shall be sized to provide a total clearance of approximately 1 inch around pipe including insulation cover. Annular space around fire rated through penetrations assemblies shall be in compliance with the Listed Assembly.

4. Packing between the pipe and sleeve in fire rated construction shall be a combination of listed insulation and fire-proof caulk.

B. Where piping passes below grade beams and footings, provide a ductile iron sleeve three sizes larger than the pipe being served. Sleeve shall be a minimum of six feet in length.

2.13 VALVE TAGS

A. Upon completion of piping installation work provide valve tags on all valves installed under the work of the mechanical sections. Valve tags shall be at least 1-1/2 inch diameter brass or engraved plastic with 1/4 inch high lettering for service designation over 2 inch high consecutively numbered valve identification. Engraved valve tags shall be color coded as specified for piping identification. Coordinate valve tag numbers with the City of PVTA facility management program. Provide service designation prefix as scheduled:

1. Plumbing Systems: Prefix:

a.	Domestic Cold Water	CW
b.	Domestic Hot Water	HW
c.	Domestic Hot Water Circulation	HWR
d.	Natural Gas	G
e.	Normally Closed	NC
f.	Unsafe Water	NP

B. Valve tags on plumbing systems may be engraved laminated plastic tags color-coded to match the pipe identification marks.

C. Identify Non-Potable water outlets with permanently attached yellow color-coded marker or 4-inch high triangle tag reading: Water Unsafe.

2.14 PIPING IDENTIFICATION

A. Provide matching flow arrows to indicate direction of flow. Markers shall be equal to Seton Setmark. Pipe marking for outside diameters of 6 inches or greater may be springs or metal bands secured to the corners at each end of the semi-rigid plastic marker to hold each end of the marker firmly against the pipe.

1. Color coding and size of legend letters shall comply with the standards of ANSI A13.1.
2. Elevated Gas piping shall be label every 10 ft, change in direction, each side of wall penetration and at shut off valve. The label letter shall be equal to the pipe size and does not need to be more than 2 inch.
3. Provide markers with legend letters sized in compliance with the following schedule:

Outside Diameter (Over Insulation)	Size of Letters:	Length of Color Code:
1-1/4 inch and smaller	1/2 inch	8 inches
1-1/2 inch to 2 inch	3/4 inch	8 inches
2-1/2 inches to 6 inches	1-1/4 inch	12 inches
8 inch	2-1/2 inch	24 inches
10 inch and larger	3-1/2 inch	32 inches

4. Plumbing Systems: Provide color-coded identification markers in compliance with the following schedule with contrasting legend letters.

Service	Identification	Color Code
Cold Water	Dom. Cold Water	Green
Hot Water	Dom. Hot Water	Yellow
Hot Water Return	Dom. Hot Water Return	Yellow
Soil or Waste	Sanitary	Green
Oil Water Waste	Oil/W	Yellow
Vent	Plumbing Vent	Green
Fuel Gas	Gas	Yellow
Elevated Gas	Elevated Gas	Yellow

2.15 IDENTIFICATION OF EQUIPMENT

A. Equipment: Stencil equipment such as pumps, water heaters, and tanks with the name of the equipment and equipment number. Coordinate equipment numbers with the User Agency's maintenance personnel. Stencils shall be at least 6 inches high and of a color to provide a contrast with the equipment finish.

B. Equipment markings shall be prominently displayed on each normally visible side of equipment. Equipment intended for installation in finished area shall have markings located behind normally used access panels mounted so as to be readily found. Equipment identification designations shall be taken from equipment schedules as indicated on the Drawings.

PART 3 – EXECUTION

3.01 IDENTIFICATION

A. All equipment and each length of pipe fitting, trap, fixture, control panel, starter and device used in the systems shall have a permanently attached nameplate or be cast, stamped or indelibly marked with the manufacturer's mark or name, the weight, type and class. The nameplates shall be kept clean and readable at all times.

B. Painting

1. Finished field painting of designated plumbing works shall be performed under Section 090001 – PAINTING.

2. All unpainted, non-insulated, non-galvanized, ferrous metal surfaces only of conduits, pipes, equipment, hangers, supports, accessories, and so forth, furnished and installed by this Subcontractor, shall be painted as follows by this Subcontractor. Concealed and Exposed - one prime coat of metal primer. Underground - two coats of black asphaltum paint.

3. Surfaces which will be inaccessible for painting after installation shall be painted before installation.

4. Surfaces to be painted shall be thoroughly cleaned of all scale, rust, dirt, oil and other foreign matter and shall be completely dry before applying paint.

5. After installation, equipment and accessories with factory primed or finished surfaces shall be cleaned, and bare or marred spots refinished and/or touched up by each Subcontractor with the same type paint and process as applied at the factory.

6. Nameplates on all equipment shall be cleaned and left free of paint.

7. Materials and workmanship shall be equal to the requirements specified under Section 090001 – PAINTING.

3.02 DISINFECTION, CLEANING AND ADJUSTING

A. Disinfection

1. Each potable water system (cold and hot water) shall be cleaned and disinfected by this Contractor. Cleaning and disinfection shall be performed after all pipes, valves, fixtures and other components of the systems are installed, tested and ready for operation.

2. All hot and cold water piping shall be thoroughly flushed with clean potable water, prior to disinfection, to remove dirt and other contaminants. Screens of faucets shall be removed before flushing and re-installed after completion of disinfection.

3. Disinfection shall be done using sodium hypochlorite in the following manner:

a. A service cock shall be provided and located at the water service entrance. The disinfecting agent shall be injected into and through the system from this cock only.

b. The disinfecting agent shall be injected by a proportioning pump or device through the service cock slowly and continuously at an even rate. During disinfection, flow of disinfecting agent into main water supply is not permitted.

c. All sectional valves shall be opened during disinfection. All outlets shall be fully opened at least twice during injection and the residual checked with ortho to lidin solution.

d. When the chlorine residual concentration, calculated on the volume of water the piping will contain indicated not less than 50 ppm (parts per million) at all outlets, then all valves shall be closed and secured.

e. The residual chlorine shall be retained in the piping systems for a period of not less than 24 hours.

f. After the retention, the residual shall be not less than five parts per million. If less, then the process shall be repeated as described above.

g. If satisfactory, then all fixtures shall be flushed with clean potable water until residual chlorine by orthotolidin tests shall be not greater than the incoming water supply. (This may be zero.)

4. All work and certification of performance shall be performed by approved applicators or qualified personnel with chemical and laboratory experience. Certification of performance shall indicate:

a. Name and location of the job and date when disinfection was performed.
b. Material used for disinfection.
c. Retention period of disinfectant in piping system.
d. ppm chlorine during retention.
e. ppm chlorine after flushing.
f. Statement that disinfection was performed as specified.
g. Signature and address of company or person performing disinfection.

5. Upon completion of final flushing (after retention period) the plumbing subcontractor shall obtain a minimum of one water sample from each hot and cold water line and submit samples to a State-approved laboratory. Samples shall be taken from faucets located at highest floor and furthest from meter or main water supply. The laboratory report shall show the following:

   a. Name and address of approved laboratory testing the samples.

   b. Name and location of job and date the samples were obtained.

   c. The coliform organism count. (An acceptable test shall show the absence of coliform organisms.)

6. If analysis does not satisfy the above minimum requirements, the disinfection procedure shall be repeated.

7. Before acceptance of the systems, this Contractor shall submit to Project Manager for his review, three (3) copies of Certification of Performance as specified above.
8. Under no circumstances shall this contractor permit the use of any portion of domestic water systems until properly disinfected, flushed and certified.

B. Cleaning and Adjusting

1. At the completion of the work, all parts of the installation shall be thoroughly cleaned. All equipment, pipe, valves and fittings shall be cleaned of grease, metal cuttings and sludge which may have accumulated by operation of the system for testing.
2. Any stoppage or discoloration or other damage to parts of the building, its finish, or furnishings due to the Plumbing sub- contractor's failure to properly clean the piping system shall be repaired by this Contractor at no increase in Contract costs.
3. At the completion of the work, all water systems shall be adjusted for quiet operation.
4. All automatic control devices shall be adjusted for proper operation.
5. All plumbing fixtures and exposed metal work shall be cleaned and polished. Floor drain strainers and traps shall be cleaned of all debris.

6. All items of equipment shall be thoroughly inspected. Any items dented, scratched or otherwise damaged in any manner shall be replaced or repaired and painted to match the original finish. All items so repaired and refinished

shall be brought to the attention of the Designer and Project Manager for inspection and approval.

3.03 SYSTEMS

A. Sanitary Waste System

1. The Plumbing subcontractor shall be responsible for checking each pipe for alignment, center line elevation and invert grade for underground installations.

2. At times when work is not in progress, open ends of pipe and fittings shall be securely closed to the satisfaction of the Project Manager so that no trench water, earth or other substance will enter the pipe or fittings. Any section of a building drainage system that is found defective in material, alignment, grade or joints before acceptance shall be corrected to the satisfaction of Project Manager. Pipe laid through rock excavation shall rest on a six-inch layer of well-compacted sand.

3. The sanitary (soil, waste and vent), storm drainage piping three inches and smaller in diameter shall pitch a minimum of 1/4 inch per foot. Piping four inches and larger in diameter shall pitch a minimum of 1/8 inch per foot.

4. The soil, waste and vent stacks shall be connected as shown and extended through the roof a minimum of 18 inches. Soil, waste and vent pipes shall be concealed unless otherwise noted.

5. Branch connections to each drainage system shall be made with "Wye" and long turn "Tee Wye" fittings. Installation of short radius 1/4 bends, common off-sets, double hub fittings and saddles will not be approved. Installation of short "Tee Wye" fittings will be permitted for vertical piping only, and only where space conditions will not permit the use of long turn fittings. Only fittings conforming to the Code shall be installed.

6. The changes in direction of each drainage system shall be made with "Wye" branches and 1/8 bends. Provide long sweep bends at bottom of stacks with a vertical cleanout just above the floor at places where a "Wye" and 1/8 bends and end cleanouts cannot be installed.

7. Every fixture shall be separately trapped and the traps must be vented unless an approved battery vented system is being installed. Floor drains shall be considered as a fixture.

8. Vents shall be connected to the discharge of each trap in the sanitary system, thence carried individually to a point above the flood level of the fixture before connecting with any other vent pipes. Pitch the branch vents back to the fixture.

9. Collect individual vent pipes together in branch vent lines and connect to vent stacks. Wherever possible, vent stack offsets shall be made with 45 degree

fittings. The vents passing through the roof shall be a minimum size of four inches in diameter.

10. Cleanouts shall be provided in drainage piping at changes in directions, at foot of stacks or other required points accessible for cleaning or rodding out.

11. Cleanouts shall be of the same size as the pipe installed in up to four inches in diameter and not less than four inches in diameter for piping larger than four inches in diameter.

12. The maximum horizontal distance between cleanouts in piping four inches in diameter and smaller shall not be more than 50 feet apart. In piping five inches in diameter and larger, cleanouts shall not be more than 100 feet apart.

13. Traps on sanitary piping not integral with fixtures and in accessible locations shall be provided with a brass trap screw protected by the water seal, and will be regarded as a cleanout.

14. Test tees with brass cleanout plugs shall be provided at the foot of all vertical soil, waste and storm drainage stacks and at each floor. Wherever cleanouts on vertical lines occur concealed behind finished walls, they shall be extended to back of finished wall, and a wall plate shall be provided.

B. Cold and Hot Water Piping

1. Vacuum breakers shall be installed on supplies to each piece of equipment to prevent back-siphonage.
2. Branch lines from water service or main lines shall be taken off the top or bottom of main, using such crossover fittings as may be required by structural or installation conditions. All water service pipes, fittings, and valves shall be kept a sufficient distance from other work to permit finished covering to be not less than 1.5 inches from other work and not less than 1.5 inches between coverings on the different services.

3. Provide shock absorbers at special equipment, tops of the risers, at each individual or each group of fixtures.

4. Water piping shall be run parallel and graded evenly to the drainage points. There shall be a 2 inch drain valve provided for each low point in the piping so that all parts of each water system can be drawn off.

5. Provide suitable means of thermal expansion for the hot water piping using swing joints, expansion loops and long-turn offsets as required to suit building conditions.

6. Piping connections to equipment shall be provided with unions or flanges to permit convenient disassembly for alterations and repairs.

7. No piping shall be installed in a manner to permit back-siphonage or any flow of water from sanitary or drainage systems into the water systems or their distribution piping under any conditions.

8. Air gaps, open end of funnel drains, and approved vacuum breaking devices shall be provided as specified or as indicated on the Drawings. Piping to hose-end faucets or hose-end fittings, or any fixtures where water supply outlet is below the fixture overflow rim shall have vacuum breakers.

9. Where flanges are installed in the water systems, red rubber gaskets shall be installed between each pair of flanges.

10. Heating or bending of copper tubing to eliminate the installation of fittings will not be permitted.

11. Piping systems shall be kept clean during all phases of work. Open ends of incomplete piping shall be protected to prevent the entrance of foreign materials.

12. Pipe shall be cut accurately to measurements established at the site and shall be worked into place without springing or forcing.

13. Provide copper-plated friction clamps on the old water supplies to each water closet and urinal flushometer. Friction clamp shall be firmly clamped to the pipe and shall be firmly attached to the adjacent wall structure.

C. Installation of Natural Gas Piping

1. General: Install natural gas piping as shown on the drawings in accordance with the State of Connecticut, International Plumbing/Gas Code as follows:

   a. Caulk spaces watertight between pipes and sleeves passing through exterior walls, slabs on grade and over crawl spaces, and waterproofed floors. Pack and seal spaces between pipes and sleeves passing through floors, walls, and ceilings of machine spaces, such as mechanical equipment, refrigeration, boiler, pump, fan, and machinery rooms at both ends of sleeve to provide an airtight acoustical barrier.

   b. Unless otherwise indicated, gas piping shall be run exposed. Where concealed piping is indicated, it shall be installed in a location to permit access to the piping with a minimum amount of damage to the building.

   c. The connection to the gas main in the street, piping and valves outside the building and meter installation shall be in accordance with local gas utility requirements.

   d. The gas supply pipe shall be of the size indicated on the drawings. Plumbing contractor shall be responsible for providing pressure regulating valve from primary stage to secondary stage. Extend gas relief vent as per 248 CMR, 704 (11).

e. A stop cock or tee handled ball valve, with cast iron extension box and cover, shall be installed in the gas supply pipe near the curb. A brass gas cock shall be installed in the gas supply pipe just inside the building wall. If the gas supply pipe is larger than 2 inch size, a bronze mounted iron body gate valve may be provided in lieu of the brass cock.

f. Joints shall be made with graphite and oil or an approved graphite compound applied to the male thread only. After cutting, and before threading, pipe shall be reamed and all burrs shall be removed. Threads shall be accurately cut, and not more than three threads shall remain exposed outside each fitting after the joint has been made up. Each length of pipe shall be hammered and all scale shall be blown out before assembling. Threaded joints shall not be caulked to prevent or stop leaks.

g. An approved type gas cock shall be installed in the branch connection to each riser and near each appliance. Plugged or capped outlets for future extensions or connections shall be provided where noted on drawings. Piping shall be graded not less than 1 inch in 40 feet of length to prevent trapping. The gas supply pipe from the main in the street to the meter shall grade up toward the meter. Horizontal lines from the meter to the risers shall grade down toward the risers and branches from risers to appliances shall grade up toward the risers and branches from risers to appliances shall grade up toward the appliances.

i. A full size tee fitting and a 6 inch long capped drip pocket shall be installed at the bottom of each riser or drop and at each low point in a horizontal gas line.

j. Uncovered, exposed pipes shall be provided with plates at the point where they pass through floors, finished walls, and finished ceilings. Where necessary to cover beads of fittings, special deep escutcheons shall be provided in lieu of plates. Plates shall be not less than 0.018 inch thick. Wall and ceiling plates shall be secured with round head set screws, not with spring clips. Unless otherwise specified, plates shall be of the one piece types. Wall and ceiling plates may be flat, hinged pattern.

k. Exterior gas piping shall have a cover of 30 inches and shall be a minimum of 3 feet from other structures such as other site piping.

l. Connections between metallic and plastic piping shall be made only underground, exterior and with an approved transition fitting. Special care shall be taken and additional supported provided with installing the exposed exterior gas piping located at the emergency generator.

2. Installation of Valves

a. Gas Valves: Provide and install gas valves at connection to gas train for each gas fired equipment item; and on risers and branches where indicated on the drawings. Locate gas valves where easily accessible and where they will be protected from possible injury.

b. Pressure Regulating Valves: Install pressure regulating valves in accordance with local utility companies requirements and manufacturer's installation instructions. Install gas shutoff valve upstream of each pressure regulating valve.

3. Equipment Connections

a. General: Connect gas piping to each gas fired equipment item, with drip leg and shutoff gas cock. Comply with equipment manufacturer's instructions.

4. Testing

a. General: Inspect, test, and purge natural gas systems in accordance local code requirements and NFPA 54 requirements and as follows.
A. Visually examine natural gas system after installation.
B. Pressure test natural gas system with dry air or nitrogen at 100 psig for 2 hours. Soap test all joints to detect leaks.

C. Flush and purge natural gas system and charge with gas in accordance with local utility requirements and NFPA 54.

3.04 GENERAL INSTALLATION REQUIREMENTS

A. Piping Installation

1. Install piping approximately as shown on the drawings and as directed during installation by the Designer’s representative.

2. Piping shall be installed as straight and direct as possible, forming right angles or parallel lines with building walls, other piping and be neatly spaced.

3. The horizontal runs of piping, except where concealed in partitions, shall be installed as high as possible.

4. Piping or other apparatus shall not be installed in such a manner as to interfere with the full swing of the doors and access to other equipment.

5. The arrangement, positions and connections of pipes, fixtures, drains, valves, and the like, indicated on the Drawings shall be followed as closely as possible.

6. It shall be possible to drain the water from all sections of each cold and hot water piping system. Pitch piping back to drain valves.

7. Screwed piping of brass or chrome-plated brass shall be made up with special care to avoid marring or damaging pipe and fitting exterior and interior surfaces.

8. Small fittings shall be taper thread. Lampwick, cord, wool or any other similar material shall not be used to make up thread joints.

9. Screwed pipe and copper tubing shall be reamed smooth before installation.

10. All exposed piping in connection with fixtures shall be chrome plated. Where chrome-plated piping is installed, cut and thread pipe so that no unplated pipe threads are visible when work is completed.

11. Reducing fittings, unless otherwise approved in special cases, shall be provided in making reduction in size of pipe. Bushings will not be allowed unless specifically approved.

12. Remove and replace with new materials, any copper or brass piping (chrome-plated or unplated) showing visible tool marks.

13. Vertical risers shall be firmly supported by riser clamps, properly installed to relieve all weight from the fittings.

14. Any piece of pipe six inches or less in length shall be considered as a nipple.

15. All water service piping shall be kept a sufficient distance from other work to permit finished covering to be not less than 1.5 inches from other work and not less than 1.5 inches between the coverings (insulation) on the different services.

B. Hanger Installation

1. All piping shall be supported from the building structure by means of approved hangers and supports, to maintain proper grading and pitching of lines, to prevent vibration and to secure piping in place, and shall be so arranged as to provide for expansion and contraction.

    a. Maximum spacing of hangers on soil pipe shall be five feet and hangers shall be provided at all changes in direction. Vertical hanger rods to support piping from the structure or supplementary steel shall not exceed four feet in total length. Where pipe support assemblies exceed four feet in total length vertically, this Contractor shall provide factory fabricated channels and all associated accessories.

    b. Friction clamps shall be installed at the base of the plumbing risers and at each floor (above or below floor slabs). Friction clamps installed above floor slabs shall not be supported from or rest on floor sleeves.

c. Provide hangers at a maximum distance of two feet from all changes in direction (horizontal and vertical) and on both sides of concentrated loads independent of the piping.

d. Hangers, in general, for all horizontal piping shall be Clevis type hangers. These hangers shall be sized to fit the outside diameter of the pipe insulation and insulation protectors (sheet metal shields) specified herein. For sprinkler/stand-pipe systems, hanger shall be approved black malleable iron, heavy duty pattern having two (2) parts bolted together.

e. All vertical drops and runouts including insulated pipes shall be supported by split ring hangers with extension rods and wall plates. These hangers shall be copper-plated when used on uncovered copper tubing. Supports on insulated vertical piping shall be sized to fit the outside diameter of the pipe insulation with 360 degrees insulation protector.

f. Provide on each horizontal insulated lines, pipe covering protectors (shields) at each hanger. Each protector shall be sized to fit the outside diameter of the pipe insulation.

g. Retaining straps shall be provided with all beam clamps.

h. All supplementary steel, including factory fabricated channels, associated accessories, and 12 inch long sheetmetal shields, throughout the project for this Section of the Specifications, both suspended and floor mounted, shall be provided by this Contractor and shall be subject to the approval of the Engineer.

i. Hangers shall not pierce the insulation on any insulated pipe.

j. Wire, tape or wood fastenings for shims or support of any pipe or tubing shall not be used.

k. Remove all rust from the ferrous hanger equipment (hangers, rods, and bolts) and apply one coat of red lead immediately after erection.

l. Piping at all equipment and each control valve shall be supported to prevent strains or distortions in the connected equipment and control valves. Piping at equipment shall be supported to allow for removal of equipment, valves and accessories with a minimum of dismantling and without requiring additional support after these items are removed.

m. All piping shall be independently supported from the building structure and not from the piping, ductwork, conduit or ceiling suspension systems of other systems.

n. Installation of hangers which permit wide lateral motions of any pipe will not be acceptable.

o. "C" clamps installed with pipe hangers or equipment hangers will not be permitted unless provided with retaining straps.

p. All no-hub cast iron pipe 6 inches or larger in diameter shall be braced to prevent horizontal movement as recommended by the Cast Iron Soil Pipe Institute by using braces, blocking or rodding as illustrated in the CISPI Handbook, Vol. II, Specification Section 310.

C. Pipe Covering Installation

1. Before pipe covering is applied, all pressure tests shall have been performed and approved by the Local Plumbing Inspector.
2. Pipe covering shall be applied over clean, dry surfaces.
3. Pipe covering shall be continuous and shall be carefully fitted with side and end joints butted firmly and tightly together and finished as specified herein.
4. Pipe covering and auxiliaries shall be kept dry during storage and application.
5. Adhesives, cements and coatings shall not be applied when the ambient temperature is below 40 degrees Fahrenheit.
6. Valve bodies shall have covering applied up to the stem.
7. It is the intent of this Specification that all vapor barriers be sealed and be continuous throughout. Staples shall not be used on vapor barrier jackets.
8. Where pipe covering ends occur at equipment or fixtures, end caps on the covering shall be provided.
9. Adequate operating clearances shall be provided at control mechanisms.
10. Pipe covering for flanges shall overlap the adjoining pipe by a minimum of three inches on each side.
11. Pipe covering shall be provided on all piping passing through ceilings and through the interior above ground sleeves (wall and floor).

12. All voids and seams in insulation shall be filled with insulating cement and finished as specified herein.
13. End joints of each section of the installed pipe covering shall be tightly butted.

D. Installation of Sleeves, Inserts and Escutcheons (New and existing floors and walls)

1. Sleeves in floors shall be set one (1) inch above the finished floor surface or as indicated on the Architectural Drawings.
2. Sleeves through interior masonry or non-masonry walls or partitions shall be set flush with the finished surfaces of the wall or partition.
3. Field drilling for inserts required for work under this Section of the Specifications shall be provided by this Contractor.
4. Each interior wall or partition sleeve shall be packed with foam or glass wool to within one inch of each face of wall, and the remaining portion of each end of sleeve to be sealed with U.L. listed fire proof caulking compound equal to the rating of the partition.
5. Escutcheons shall be installed around all exposed insulated or bare pipe, except water closet starts or bends passing through a finished floor, wall or ceiling. Escutcheons shall fit snugly around the bare pipe or insulated pipe.

E. Valve Installation

1. Location of Valves: There shall be valves where indicated on the drawings and where specified as follows:

    a. At building service entrances, foot of all supply risers, branches to groups of fixtures, branches to separate fixtures, equipment, wall hydrants, hose bibbs, connections to other systems and sectionalizing points in each system.
    b. Each fixture supply shall have a separate angle stop or straight stop finished like the pipe it services.
    c. Each piece of equipment shall have isolation valves for each service connected.
    d. At the foot of each riser, on the inlet and outlet side of control valves.
    e. At the low points of each water system including trapped sections, provide a tee with 2 inch branch and valve with 3/4 inch hose end adapter and attached chain with cap.
    f. Valves shall be located to permit easy operation, replacement or repair.

F. Installation of Gauges and Thermometers

1. Thermometers and pressure gauges shall be installed in such a manner as to cause a minimum restriction to the flow in the pipes and so that they can be easily read from the floor.
2. Thermometers shall be installed in the outlet piping from the hot water heater.
3. Pressure gauges in the cold water system shall be installed at the water meter.

G. Sewer Connections

1. Connections to the site sewer within 10’ of the building shall be in accordance with local regulations. Coordinate sewer inverts with the site contractor

H. Installation of Trap Primers

1. Install trap primers with piping pitched towards drain trap, minimum of 1/8 inch per foot (1 percent). Adjust trap primer for proper flow.

I. Blending Valve Installation

1. All piping shall be thoroughly flushed before the blending valve is installed. Insure that hot and cold water piping are connected to proper
2. Follow manufacturers instructions for setting of maximum allowable temperature limits allowed by code.
3. Valve must be flowing when setting temperature.

J. Installation of Cleanouts and Ferrules

1. Riser Connection to Sewer or Drain: Where soil, waste, or roof drainage risers connect to a sewer or drain extending from the building above the lowest floor, the fitting at the base of each stack or downspout shall be a sanitary tee or a combination Y and 1/8 bend with cleanout plug in the end of the run of the main.

2. Test Tees: Each vertical soil, waste, and vent pipe and each downspout and roof drainage pipe which connects to horizontal drain piping below ground shall be fitted with a test tee above the lowest floor or ground. Where accessible, test tee may be installed in the horizontal pipe at the base of the riser.
3. Cover Plates: Where cleanouts or test tees occur on concealed pipes in finished rooms, they shall be provided with a 1/8-inch thick, machine finished, brass cover plate of sufficient diameter to cover the opening in the finished wall or partition. The cleanout plug shall have a solid head, tapped for a 1/4-inch brass screw to secure the cover plate. Where cleanout plugs extend beyond the wall finish, the cover plates shall be of machine finished brass and shall be only of sufficient depth to fit against the wall to cover plug. Cleanout cover plates shall be painted to match adjacent wall finish.

4. Cleanouts Plugs For Threaded Fittings: Cleanout plugs for threaded fittings shall be in accordance with ANSI B16.12. Except for test openings, where size must be sufficient to admit test plug, bushings will be permitted on pipes 5-inches and larger to reduce plug size to 4 inches; cleanout plugs for piping 4 inches and smaller shall be the same size as the pipe.

5. Cleanout Plugs For Hub-and-Spigot Fittings: Cleanout plugs for hub-and-spigot fittings shall be screwed into ferrules caulked into the fitting. Ferrules and plugs shall be in accordance with ANSI B16.12, except that plugs required to be flush with the floor shall have square countersunk heads in lieu of raised heads.

6. Cleanout Plugs For Copper Drainage Lines: Cleanout plugs on copper drainage lines shall be installed in solder-joint fittings having threaded openings provided for the cleanout, or in solder-joint fittings with threaded adapters.

3.05 INSPECTION AND TESTS

A. General

1. All labor, materials, instruments, devices and power required for testing shall be provided by the Plumbing Subcontractor. The tests shall be performed in the presence and to the satisfaction of the Designer and such other parties as may have legal jurisdiction. No piping in any location shall be closed up, furred in, or covered before testing and approval by the Local Plumbing Inspector and Project Manager.

2. Where portions of piping systems are to be covered or concealed before completion of the project, those portions shall be tested separately in the manner specified herein for the respective entire system.

3. Any piping or equipment that has been left unprotected and subject to mechanical or other injury in the opinion of Owner’s Project Manager shall be retested in part or in whole as directed.

4. The Authority retains the right to request a recheck or resetting of any pump or instrument by the Plumbing Subcontractor during the guarantee period at no additional cost to the Contract.

5. Repair, or if directed by Project Manager, replace any defective work with new work without extra cost to the contract. Repeat tests as directed, until the work is proven to meet the requirements specified herein.

6. Restore to its finished condition any work, provided by other Contractors, damaged or disturbed by tests. The Plumbing Subcontractor shall engage the original Contractor to do the work of restoration to the damaged or disturbed work.

7. The fixtures shall be tested for stability of support and satisfactory operation. The piping shall be tested when directed by the Designer, Local Plumbing Inspector for stability of support.
8. After the fixtures are set and connected, and the piping systems to same have been tested, the Plumbing Subcontractor shall turn water on to the fixtures, equipment, fill the traps, etc., and the proper operation of all items shall be demonstrated by him in the presence of and to the satisfaction of the Engineer, Owner's Project Manager, Plumbing Inspector, or their designated representative.
9. Caulking of screwed joints or holes in piping will not be acceptable.

10. The Plumbing Subcontractor shall notify the Designer, Owner's Project Manager and all inspectors having jurisdiction, a minimum of 48 hours in advance of making any required tests so that arrangements may be made for their presence to witness scheduled tests.

B. Specific

1. Sanitary Piping Systems:

   a. Before the installation of fixtures, equipment and insulation, each system including vents shall have all necessary openings plugged to permit the entire system to be tested in accordance with the State Plumbing Code. Each system shall hold this water without a drop in water level. Test to be witnessed by Local Plumbing Inspector and Project Manager.

   b. Where a portion of the system is to be tested, the test shall be accomplished with a vertical stack ten feet above the highest horizontal line to be tested may be installed, and filled with water to maintain sufficient pressure. A pump may be used to supply the required pressure. The pressure shall be maintained for a minimum of four hours for sufficient time to permit inspection of all joints.

2. Natural Gas pipe testing

a. General: Inspect, test, and purge natural gas systems in accordance local code requirements and NFPA 54 requirements and as follows.
b. Visually examine natural gas system after installation.
c. Pressure test natural gas system with dry air or nitrogen at 100 psig for 2 hours. Soap test all joints to detect leaks.
d. Flush and purge natural gas system and charge with gas in accordance with local utility requirements and NFPA 54.

3. Cold and Hot Water Piping System:

a. Upon completion of the roughing-in and before setting fixtures and final connections to all equipment, all water piping systems shall be tested to a hydrostatic pressure of 150 pounds per square inch.
b. Each systems test shall be maintained for eight hours without a drop in pressure. These tests to be witnessed by Local Plumbing Inspector and Owner's Project Manager.
c. After testing, provide complete adjustment of all parts of each water system until design distribution or balancing is obtained throughout.

3.06 SPECIAL RESPONSIBILITIES

A. Coordination: Cooperate and coordinate with work of other Sections in executing work of this Section.

1. Perform work such that progress of entire project including work of other Sections shall not be interfered with or delayed.

2. Provide information as requested on items furnished under this Section which shall be installed under other Sections.

3. Obtain detailed installation information from manufacturers of equipment provided under this Section.

4. Obtain final roughing dimensions or other information as needed for complete installation of items furnished under other Sections or by User Agency.
5. Keep fully informed as to shape, size and position of openings required for material or equipment to be provided under this and other Sections. Give full information so that openings required by work of this Section may be coordinated with other work and other openings and may be provided for in advance. In case of failure to provide sufficient information in proper time, provide cutting and patching or have same done, at own expense and to full satisfaction of Designer.
6. Provide information as requested as to sizes, number and locations of concrete housekeeping pads necessary for floor-mounted vibrating and rotating equipment provided under this Section.
7. Notify Designer of location and extent of existing piping, ductwork and equipment that interferes with new construction. In coordination with and with approval of Designer, relocate piping, ductwork and equipment to permit new

work to be provided as required by Contract Documents. Remove non-functioning and abandoned piping, ductwork and equipment as directed by Designer. Dispose of or store items as requested by Designer.

B. Installation Only Items

1. Where this contractor is required to install items which it does not purchase, it shall coordinate their delivery and be responsible for their unloading from delivery vehicles and for their safe handling and field storage up to the time of installation. This trade shall be responsible for:
   a. Any necessary field assembly and internal connections, as well as mounting in place of the items, including the purchase and installation of all dunnage supporting members and fastenings necessary to adapt them to architectural and structural conditions.
   b. Their connection to building systems including the purchase and installation of all terminating fittings necessary to adapt and connect them to the building systems.

2. This Contractor shall carefully examine such items upon delivery. Claims that any of these items have been received in such condition that their installation will require procedures beyond the reasonable scope of work of this contractor will be considered only if presented in writing within one week of their date of delivery. Unless such claims have been submitted this contractor shall be fully responsible for the complete reconditioning or replacement of the damaged items.

C. Maintenance of equipment and systems: Maintain Plumbing equipment and systems until Final Acceptance. Ensure adequate protection of equipment and material during delivery, storage, installation and shutdown and during delays pending final test of systems and equipment because of seasonal conditions. Do not use boilers before providing water treatment where required; this includes use of boilers for temporary heat or for testing.

D. Use of premises: Use of premises shall be restricted as directed by Designer and as required below.

1. Remove and dispose of dirt and debris, and keep premises reasonably clean. Upon completion of work, remove equipment and unused material. Put building and premises in neat and clean condition, and do cleaning and washing required to provide acceptable appearance and operation of equipment, to satisfaction of Designer and as specified under CLEANING paragraph.
2. It shall be this trade's responsibility to store his materials in a manner that will maintain an orderly clean appearance. If stored on-site in open or unprotected areas, all equipment and material shall be kept off the ground by means of pallets or racks, and covered with tarpaulins.
3. Do not interfere with function of existing sewers and water mains. Extreme care shall be observed to prevent debris from entering ductwork. Confer with Designer as to disruption of heating services or other utilities due to testing or connection of new work to existing. Interruption of heating services shall be

performed at time of day or night deemed by Designer to provide minimal interference with normal operation. Obtain Designer's approval of the method proposed for minimizing service interruption.

E. Surveys and measurements:

1. Base measurements, both horizontal and vertical, on reference points established by Contractor and be responsible for correct laying out of work.

2. In event of discrepancy between actual measurements and those indicated, notify Designer in writing and do not proceed with work until written instructions have been issued by Designer.

3.07 MATERIALS AND WORKMANSHIP

A. Work shall be neat and rectilinear. Piping shall run concealed except in mechanical rooms and areas where no hung ceiling exists. Install material and equipment as required by manufacturers. Installation shall operate safely and without leakage, undue wear, noise, vibration, corrosion or water hammer. Work shall be properly and effectively protected, and pipe openings shall be temporarily closed to prevent obstruction and damage before completion.

B. Except as specified otherwise, material and equipment shall be new. Provide supplies, appliances and connections necessary for complete and operational installation. Provide components required or recommended by OSHA and applicable NFPA documents.

C. References to manufacturers and to catalog designation, are intended to establish standards of quality for materials and performance but imply no further limitation of competitive bidding.

D. Finish of materials, components and equipment shall be as approved by Designer and shall be resistant to corrosion and weather as necessary.

E. The owner will not be responsible for material and equipment before testing and acceptance.

3.08 CONTINUITY OF SERVICES

A. Do not interrupt existing services without Owner’s Project Manager's approval.
B. Schedule interruptions in advance, according to Owner’s Project Manager's instructions. Submit, in writing, with request for interruption, methods proposed to minimize length of interruption.
C. Interruptions shall be scheduled at such times of day and work so that they have minimal impact on User Agency's operations.

3.09 ANCHORS AND INSERTS

A. Inserts shall be iron or steel of type to receive machine bolt head or nut after installation. Inserts shall permit adjustment of bolt in one horizontal direction and shall develop strength of bolt when installed in properly cured concrete.
B. Provide anchors as necessary for attachment of equipment supports and hangars.

3.10 INSTALLATION OF EQUIPMENT

A. Avoid interference with structure and with work of other trades, preserving adequate headroom and clearing doors and passageways, to satisfaction of Designer and in accordance with code requirements. Installation shall permit clearance for access to equipment for repair, servicing and replacement.

B. Install equipment so as to properly distribute equipment loads on building structural members provided for equipment support under other Sections. Roof-mounted equipment shall be installed and supported on structural steel provided under other Sections.
C. Provide suspended platforms, strap hangers, brackets, shelves, stands or legs as necessary for floor, wall or ceiling mounting of equipment provided under this Section (e.g. heating and ventilating units, fans, ducts and piping) as indicated on Drawings and in Specifications.
D. Provide steel supports and hardware for proper installation of hangers, anchors, guides, etc.
E. Provide cuts, weights, and other pertinent data required for proper coordination of equipment support provisions and installation.
F. Structural steel and hardware shall conform to Standard Specifications of ASTM; use of steel and hardware shall conform to requirements of Section Five of Code of Practice of American Institute of Steel Construction.
G. Verify site conditions and dimensions of equipment to ensure access for proper installation of equipment without disassembly which will void warrantee. Report in writing to Designer, prior to purchase or shipment of equipment involved, on conditions which may prevent proper installation.

3.11 COMMISSIONING OF EQUIPMENT AND SYSTEMS

A. The owner’s commissioning agent will check the completed installation either sequentially as different parts are completed, or when the entire installation is complete, at the sole option of the Commissioning Agent.
B. Prior to the commissioning agent’s checking a part of the installation or the entire installation, this contractor shall submit a letter signed by an officer of this contracting company or an officer of the general contractor stating that:
    1. he is a an officer of the company,
    2. he has personally inspected the installation to be checked,
    3. the date of his inspection,
    4. the installation is complete and tested and ready to be inspected by the Designer, and that all required test reports have been submitted.

C. This sub contractor shall arrange that an officer of this contracting company or of the general contractor, as well as the commissioning agent and Owner’s Project Manager, shall witnesses the necessary test, in addition to this contractor’s personal run the

respective tests. At the conclusion of each such test this sub contractor shall submit a letter signed by the officer stating that:

1. he is an officer of the company,
2. he has personally witnessed the test (give the name of the test),
3. the date of testing,
4. the results of testing, as compared to specified performance,
5. listing the name, title, and company affiliation of all those witnessing the test.

3.12 PAINTING

A. Equipment shall have shop coat of non-lead gray paint. Hangers and supports shall have one coat of non-lead red primer. Complying with IEQ requirements specified under section 090007-Painting. Machinery such as pumps, fans, etc., shall be stenciled with equipment name. Stencil shall be at least 6" high for large equipment, 2" high for small equipment. Finish painting, including painting of various piping and duct systems, shall be done under other Sections.

3.13 SYSTEM SHUTDOWNS

A. Coordination shutdowns of existing systems with the Project Manager and submit a written request at least ten working days in advance. Minimize system shut downs as much as possible. Submit a list of all effected areas, the proposed work to be performed, and the expected length of the shut-down including time for retesting.

B. Provide temporary services to maintain active system during extended shut-downs as required for demolition and construction phasing.

3.14 CORE DRILLING

A. Do not core new or existing concrete structure without written approval from the Structural Engineer.

B. Perform all core drilling required for the proper installation of this Section. Locate all required openings and prior to coring. Coordinate the opening with the other Trades and obtain approval from the Structural Engineer.

C. Thoroughly investigate the existing conditions in the vicinity of the required opening prior to cutting. Take care so as not to disturb the existing building systems. Damage to existing conditions incurred during core drilling shall be corrected to the Owner Project Manager’s satisfaction with no additional expense to the contract.

3.15 OPERATION AND MAINTENANCE TRAINING REQUIREMENTS

1) Refer to Specification section 017900 Demonstration and Training

2) Training Preparation Conference: Before operation and maintenance training, CxA shall convene a training preparation conference to include Owner's operation and maintenance personnel, Contractor, and subcontractors. Perform the following:

1. Review installed systems, subsystems, and equipment.
2. Review instructor qualifications.
3. Review instructional methods and procedures.

4. Inspect and discuss locations and other facilities required for instruction.

B. Training Modules: Develop an instruction program that includes individual training modules for each system, subsystem, and equipment.

END OF SECTION

SECTION 23 00 01 - HEATING, VENTILATING AND AIR CONDITIONING

PART 1 - GENERAL

1.1 GENERAL PROVISIONS

A Division 1 is hereby made a part of this Specification Section.

B GENERAL PROVISIONS

1. Examine all Drawings and all Sections of the Specifications and requirements and provisions affecting the work of this Section.

1.2 SCOPE OF WORK

A The work under this Section shall include the furnishing of all materials, labor, equipment and supplies and the performance of all operations to provide complete working systems, in general, to include the following items:

1. Air Handling Units.
2. Infrared Heater
3. Ductwork
4. Diffusers, Registers and Grilles
5. Exhaust Fans
6. Insulation
7. Variable Frequency Drives
8. Roof Curbs
9. Automatic Temperature Control Systems
10. Core drilling, cutting and channeling for HVAC equipment for holes five (5) inches and less in diameter.
11. Fire stopping of penetrations made by/for this contractor.
12. Furnish and maintain safe and adequate conditions, all staging and scaffolding that is required for the work of this section.
13. Hoisting and rigging for equipment and materials specified herein.
14. Testing and balancing

B Provide any other component or related system (whether or not listed) which is part of the overall design and basic equipment and deemed necessary for its completion, thoroughness and readiness for operation in perfect condition.

A. List of Drawings: The work to be completed by the subcontractor for the work of this Section is shown on the drawings. The Subcontractor shall carefully inspect all the listed drawings, not just those pertaining particularly to this sub-trade unless specifically called out otherwise, regardless of where among the drawings it appears. Examine all drawings and all other sections of the specifications for requirements therein affecting the work of this Section.

B. The HVAC Subcontractor shall, at all times, have a foreman or superintendent on the project authorized to make decisions and receive instructions as if the HVAC Subcontractor himself were present. The foreman or superintendent shall not be removed or replaced without the express approval of the Architect-Engineer after construction work begins. The HVAC Subcontractor shall employ only competent and experienced workmen at a regular schedule in harmony with the other tradesmen on the job. The HVAC Subcontractor shall also exercise care and supervision of his employees in regard to proper and expeditious layout of his work.

C. It shall be the HVAC contractors responsibility to submit all documentation required of these sections pertaining to division 230001 work.

D. Air Filters:

It is the intent of this specification that all equipment requiring or specified with air filters be furnished with one spare sets of filters for each piece of equipment in addition to those supplied with the unit. All filters shall have minimum efficiency of MERV 8.

1.3 RELATED WORK

A. Examine all other sections of the Specifications and all drawings for the relationship of the work under this Section and the work of other trades. Cooperate with all trades and coordinate all work under this section therewith.

B. The following related items are included under sections listed below:

1. Concrete bases and thrust blocks, housekeeping pads and filling inertia pads for HVAC equipment. SECTION 033000 – CAST IN PLACE CONCRETE.

2. Openings for Air Intake Devices. In APPLICABLE SECTIONS, in which they occur.

3. Flashing of ductwork and roof curbs for HVAC equipment. SECTION 070002, ROOFING AND FLASHING.

4. Painting of all exposed ductwork and other mechanical equipment not having enameled, surfaces, stainless steel or chromed finishes, SECTION 090007, PAINTING.

5. In general, all wiring required for equipment provided by the HVAC Contractor that requires Automatic Controls and all interlock wiring for this HVAC equipment that is not shown or indicated on the Electrical Drawings of SECTION 260001 ELECTRICAL, shall be provided under SECTION 230001, HVAC.

6. Gas vent piping for the infrared heater gas train shall be provided under SECTION 220001 PLUMBING and shall be coordinated with the work of this section.

1.4 PRODUCTS FURNISHED, BUT NOT INSTALLED UNDER THIS SECTION

A. Furnish pipe sleeves for placement into formwork by the General Contractor.

B. Furnish access doors and panels to be installed by the applicable sections.

1. Access panels will be installed under the Section of the related trades of the finished surfaces in which they are located.

C. Furnish standard roof curbs and equipment supports for installation by SECTION 070002-Roofing.

1.5 REFERENCES

A. For products or workmanship specified by association, trade, or federal standards, comply with the requirements of the standard, except when more rigid requirements are herein specified or are required by applicable codes.

B. The date of the standard is that in effect at the Bid date.

C. Schedule of References:

1. AABC Associated Air Balance Council
1518 K Street, N.W.
Washington, DC 20005

2. ABMA American Boiler Manufacturers Association
950 N. Glebe Road
Suite 160
Arlington, VA 22203

3. ARI Air-Conditioning and Refrigeration Institute
4301 North Fairfax Drive, Suite 425
Arlington, VA 22203

4. ASHRAE American Society of Heating, Refrigeration and Air Conditioning
Engineers, Inc.
1791 Tullie Circle N.E.
Atlanta, GA 30329

5. AWS American Welding Society, Inc.
P.O. Box 351040
550 NW LeJeune Road
Miami, FL 33135

6. FM SMACNA Sheet Metal and Air Conditioning Contractor's National Association, Inc.

4201 Lafayette Center Drive
Chantilly, VA 22021

1.6 DEFINITIONS

A. As used in this Section, the following terms shall be understood to have the following meaning:

1. Work: all labor, materials, equipment, apparatus, controls, accessories and all other items required for a proper and complete installation.
2. Concealed: hidden from sight in chases, furred in spaces, shafts, embedded in construction, in a crawl space, and above hung ceilings.
3. Exposed: not installed underground or concealed as defined above.
4. "Furnish" shall mean purchase and deliver to the project site, complete with every necessary appearance and support.
5. "Install" shall mean unload at the delivery point at the site and perform all work necessary to establish secure mounting, proper location and operation in the project.
6. "Provide" shall mean furnish and install.
7. "Furnished by others" shall mean materials or equipment purchased and set in place under other sections of the general contract and connected to the systems covered by this Section of the specifications by this trade contractor.
8. "Coordinate" shall mean all work provided under this Section of the specification shall be in compliance with work of other trades.
9. “HVAC Subcontractor,” “Subcontractor,” or “Installing Contractor” shall be the Subcontractor responsible for the Work of this Section of the Specifications, and shall be responsible for coordination of the Work of this Section of the Specifications with the Work of Paragraph 2.57-Automatic Temperature Controls, where applicable.
10. “ATC” shall mean Automatic Temperature Controls, and shall be interchangeable with HVAC Control Systems.

1.7 CODES, ORDINANCES AND PERMITS

A. Unless otherwise specified or indicated, materials, workmanship and equipment performance shall conform with the latest governing edition of the following standards, codes, specifications, requirements, and regulations, but not limited to:

1. All Applicable NFPA Standards
2. International Mechanical Code 2021
3. State and Local Building Mechanical and Energy Codes
4. American Society of Mechanical Engineers
5. American Society of Testing and Materials
6. American National Standards Institute
7. Underwriters' Laboratories, Inc.

8. Occupational Safety and Health Administration

B. Any other local codes or authorities having jurisdiction including any other standards specifically indicated in other paragraphs of this specification.

C. All pressure vessels shall conform to ASME and state codes and regulations.

D. All equipment shall meet the more efficient requirement:

1. As shown on bid documents, or

2. Minimum efficiencies state in the energy code.

E. This Subcontractor shall give all notices, file all plans, obtain all permits and licenses, and obtain all necessary approvals from authorities having jurisdiction. Deliver all certificates of inspection to the authorities having jurisdiction. No work shall be covered before examination and approval by Architect, inspectors, and authorities having jurisdiction. Replace unacceptable work to conform to requirements, satisfactory to Architect, and without extra cost to the Owner. If work is covered before inspection and approval, this Subcontractor shall pay costs of uncovering and reinstalling the covering, whether it meets contract requirements or not.

1.8 SUBMITTALS

A. Conform to the requirements of Section 013300-Submittals, for schedule and form of all submittals. Coordinate this submittal with submittals for all other finishes. Submit plans with location of pipe penetration in structural slabs.

B. Shop drawings and design layouts shall be prepared by licensed installing contractors and shall note the name(s), license number(s) and license expiration date(s) of the contractor(s) installing the heating, piping and refrigeration systems.

C. Material List: Before purchasing materials for the work, submit to the Architect a complete list showing (1) the materials specified, and (2) the equivalent materials proposed for use, including description of product, if the Subcontractor desires to use materials other than those specified.

1. All materials shall be approved by the Architect before commitment for materials is made. Intention of using specified materials shall not relieve the Subcontractor from submitting the above list.

D. Product Data: Submit complete manufacturer's product description and technical information including:

1. Air Handlling Unit .
2. Infrared heater
3. Ductwork
4. Diffusers, Registers and Grilles
5. Fans
6. Insulation

7. Roof Curbs
8. HVAC Control Systems

E. Submit shop drawings and product data grouped to include complete submittals of related systems, products and accessories in a single submittal.

1. Access panel shop drawings shall be submitted to the Architect for approval.

2. Do not submit multiple product information in a single bound manual.

3. Three-ring binders shall not be accepted.

F. In the event that the Subcontractor fails to provide Shop Drawings for any of the products specified herein:

1. Subcontractor shall furnish and install all materials and equipment herein specified in complete accordance with these Specifications.

2. Subcontractor furnishes and installs material and/or equipment which is not in complete accordance with these Specifications, he shall be responsible for the removal of this material and/or equipment from the Work, and shall be responsible for the replacement of this material and/or equipment with material and/or equipment which is in complete accordance with these Specifications, at the direction of the Owner's Representative.

3. Removal and replacement of materials and/or equipment which are not in complete compliance with these Specifications shall be executed by the Subcontractor at no extra cost to the Owner.

4. Removal and replacement of materials and/or equipment which are not in complete compliance with these Specifications shall not be allowed as a basis for a claim of delay of completion of the Work.

G. Mark dimensions and values in units to match those specified.

H. Submit Material Safety Data Sheets (MSD) on each product with submittal.

1.9 OPERATION AND MAINTENANCE (O&M) DATA

A. Refer to SECTION 017700 – PROJECT CLOSEOUT

B. Prepare and submit Operating and Maintenance manuals at least two (2) months prior to the date of Substantial Completion of the Project. Submit six complete sets of operation and maintenance data complete with at least the following.

C. Table of Contents:

1. Introduction:

   a. Explanation of Manual and its use

2. Plant Operation:

a. Heating/Cooling Plant Instructions

b. Operating Instructions for all Pumps, Air Handling Apparatus, Terminal Units, Boilers, Split System A/C Units, Fans, etc.

3. Maintenance

a. Maintenance and Lubricating Chart: furnish three sets of charts indicating equipment tag number, location of equipment, equipment service, greasing and lubricating requirements, lubricants and intervals of lubrication. One chart shall be framed under glass and mounted where directed by the Architect.

b. Recommended List of Spare Parts: furnish two typed sets of instructions for ordering spare parts with sectional views of the fittings or equipment showing parts numbered or labeled to facilitate ordering replacements. Each set shall include a list with itemized prices of those parts recommended to be kept on hand as spares, as well as the name and address of where they may be obtained.

4. Manufacturer's Literature:

a. Air handler and Make up air
b. Infrared Heater
c. Ductwork
d. Diffusers, Registers and Grilles
e. Fans
f. Insulation
g. Roof Curbs
h. HVAC Control Systems

5. Manufacturer's Nameplate

a. Each item of equipment shall have a nameplate bearing the manufacturer's name, address, model number, and serial number securely affixed in a conspicuous place; the nameplate of the distributing agent will not be acceptable.

1.10 MATERIAL AND EQUIPMENT STANDARD

A. Where equipment or materials are specified with the name of a manufacturer, such specification shall be deemed to be used for the purpose of establishing a standard for that particular item. No equipment or material shall be used unless previously approved by the Architect.

B. Substitutions may be offered for review provided the material, equipment or process offered for consideration is equal in every respect to that indicated or specified. The Request for each substitution must be accompanied by complete specifications together with drawings or samples to properly appraise the materials, equipment or process.

C. If a substitution of materials or equipment in whole or in part is made, this HVAC Subcontractor shall bear the cost of any changes necessitated by any other trade as a result of said substitution.

D. All materials, equipment and accessories provided under this Section shall be new and unused products of recognized manufacturers as approved.

1.11 ELECTRICAL WORK

A. All electrical apparatus and controls furnished as a part of the work of this Section, but which are not integral with the equipment served, will be mounted by the Electrical Subcontractor and all wiring will be done under Division 26.

B. Except for electrical apparatus specifically called for as part of this Section, all switches and controllers required will be provided under Division 26.

C. All electrical apparatus and controls furnished as a part of the HVAC work shall conform to applicable requirements under Division 26.

1.12 RECORD DRAWINGS

A. Refer to SECTION 011000 – SUMMARY OF WORK and SECTION 017700 – PROJECT CLOSEOUT.

B. All costs for Record Drawings shall be borne by the HVAC Subcontractor.

C. Maintain at the job site at all times, a complete set of black line prints of the HVAC Drawings. As the work progresses, mark all changes made, whether resulting from addenda, formal change orders or other instructions issued by the Architect. Color in the various ductwork, piping, equipment, apparatus and associated appurtenances exactly as they are erected.

D. The accurate location, depth, size and type of all concealed items shall be recorded before concealment to ensure accurate and direct future access doors and panels. Show inverts of all services at key points within the building, or buried items, and entering and leaving the building. Show dimensions from building grid lines.

E. The record drawings will be reviewed at regular intervals by the Architect and will be taken into consideration when reviewing the monthly applications for payment submitted by the HVAC Subcontractor.

1.13 WARRANTIES

A. Submit manufacturer's standard replacement warranties for material and equipment furnished under this Section. Such warranties shall be in addition to and not in lieu of all liabilities, which the manufacturer and the HVAC Subcontractor may have by law or by provisions of the Contract

Documents. All refrigeration compressors such as Condensing unit shall have the manufacturer's extended replacement warranty for a total of five years. Condensing Boiler shall have burner replacement warranty for five years. The Rooftop Unit, VRV system shall have warranty of one year.

B. All materials, equipment and work furnished under this Section shall be guaranteed against all defects in materials and workmanship for a minimum period of 24 months commencing with the Date of Substantial Completion. Any failure due to defective material, equipment or workmanship which may developed, shall be corrected at no expense to the Owner including all damage to areas, materials and other systems resulting from such failures.

C. Guarantee that all elements of each system meet the specified performance requirements as set forth herein or as indicated on the Drawings.

D. Upon receipt of notice from the Owner of the failure of any part of the systems during the guarantee period, the affected parts shall be replaced. Any equipment requiring excessive service shall be considered defective and shall be replaced.

1.14 COORDINATION

A. The work shall be so performed that the progress of the entire building construction, including all other trades, shall not be delayed nor interfered with. Materials and apparatus shall be installed as fast as conditions of the building will permit and must be installed promptly when and as required.

B. Confer with all other trades relative to location of all apparatus and equipment to be installed and select locations so as not to conflict with work of other Sections. Any conflicts shall be referred immediately to the Architect for decision to prevent delay in installation of work. All work and materials placed in violation of this clause shall be readjusted to the Architect's satisfaction at no expense to the Owner.

C. Keep fully informed as to the shape, size and position of all openings required for all apparatus, piping, ductwork, etc., and give information in advance to build openings into the work. Furnish all sleeves, pockets, supports and incidentals, and coordinate with the General Contractor for the proper setting of same.

D. All distribution systems, which require pitch or slope such as condensate drains and water piping, shall have the right of way over those, which do not.

E. The HVAC Subcontractor shall, with the approval of the Architect and without extra charge, make reasonable modifications in his work as

required by normal structural interferences, or by interference with work of other trades, or for proper execution of the work.

F. Keep fully informed as to the size, shape and location of all openings required for the work of this Section and give full information to all Subcontractors and the General Contractor.

G. Coordination Meeting: The Boiler and RTU Controller supplier or designated rep. shall meet with the Automatic temperature control contractor to coordinate details of the wiring requirements.

1.15 COORDINATION DRAWINGS

A. Refer to SECTION 013300 –SUBMITTALS and SECTION 017700 PROJECT CLOSEOUT for coordination drawings submittal requirements and use of project CAD Files.

B. Indicate clearances and advise other trades of clearance requirements for operation, repair, removal and testing of mechanical equipment.

C. Indicate aisle ways and access ways required on coordinated shop drawings for mechanical equipment rooms, electrical rooms, computer rooms, and kitchens.

D. HVAC Coordination Drawings

1. The HVAC subcontractor shall prepare Coordination Drawings showing all HVAC work to be installed as part of this Section. The HVAC Coordination Drawings shall show all equipment, pipes, sleeves, inserts, ducts, registers, diffusers and supports.

2. The HVAC subcontractor after showing all of the HVAC work shall forward the reproducible Coordination Drawings to the Contractor.

3. The HVAC subcontractor shall not install any of his work prior to the preparation of the final Coordination Drawings. If HVAC work proceeds prior to the final Coordination Drawings, any change to the HVAC work to correct the interferences and conflicts which result will be made by the HVAC subcontractor at no additional cost to the Owner.

4. Coordination Drawings are for the HVAC subcontractor's and Construction Supervisor's use during construction and shall not be construed as replacing any shop, "as-built", or Record Drawings required elsewhere in these Contract Documents.

5. Construction Supervisor's review of Coordination Drawings shall not relieve the HVAC subcontractor from his overall responsibility for coordination of all work performed pursuant to the Contract or from any other requirements of the Contract.

6. No Coordination shall allow the passing of any pipe or conduit through any ductwork system.

1.16 INTERPRETATION OF DRAWINGS AND SPECIFICATIONS

A. It is the intention of the Specifications and Drawings to call for complete, finished work, tested and ready for continuous operation. Any apparatus, appliance, material or work not shown on the Drawings, but mentioned in the Specifications or vice versa, or any incidental accessories necessary to make the work complete in all respects and ready for operation, even if not particularly specified, shall be provided by the HVAC Subcontractor or his/her Sub-subcontractors, without additional expense to the Owner.

B. The Drawings are generally diagrammatic. The locations of all items that are not definitely fixed by dimensions are approximate only. The exact locations must be determined at the site and shall have the approval of the Architect before being installed. The HVAC Subcontractor shall follow Drawings, including shop drawings, in laying out work and shall check the Drawings of other trades to verify spaces in which work will be installed. Maintain maximum headroom and space conditions. Where space conditions appear inadequate, notify the Architect before proceeding with the installation. The HVAC Subcontractor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.

C. Refer to the Architectural, Structural, Fire Protection, Plumbing and Electrical Drawings and coordinate location and requirements of all HVAC equipment.

D. Sizes of ducts and pipes and routing are shown, but it is not intended to show every offset and fitting, nor every structural difficulty that may be encountered. To carry out the intent and purpose of the Drawings, all necessary parts to make complete approved working systems ready for use, shall be furnished without extra charge.

1.17 SURVEY AND MEASUREMENTS

A. Base all required measurements, horizontal and vertical, from referenced points established by the Contractor and be responsible for correctly laying out the Work required under this Section of the Specification.

B. In the event of discrepancy between actual measurements and those indicated, notify the Contractor in writing and do not proceed with the related work until instructions have been issued.

1.18 DELIVERY, STORAGE AND HANDLING

A. No materials shall be delivered or stored on site until Shop Drawings have been approved.

B. All manufactured materials shall delivered to the site in original packages or containers bearing the manufacturer's labels and product identification.

C. Protect materials against dampness. Store off floors, under cover, and adequately protected from damage.

1.19 PROTECTION OF WORK AND PROPERTY

A. This Contractor shall be responsible for the care and protection of all work included under this Section until the completion and final acceptance of this Contract.

B. Protect all equipment and materials from damage from all causes including, but not limited to, fire, vandalism and theft. All materials and equipment damaged or stolen shall be repaired or replaced with equal material or equipment at no additional cost to the Owner.

C. Protect all equipment, outlets and openings with temporary plugs, caps and covers. Protect work and materials of other trades from damage that might be caused by work or workmen under this Section and make good damage thus caused.

D. Damaged materials are to be removed from the site; no site storage of damaged materials will be allowed.

1.20 SUPERVISION

A. Provide a Construction Supervisor with a minimum of 5 years of experience in HVAC Construction Supervision who shall be responsible for the installation of the Work of this Section of the Specifications, and in accordance with this Section of the Specifications and with the Contract Drawings.

1.21 SAFETY PRECAUTIONS

A. Life safety shall be a primary consideration. Provide all required and prudent material, labor and equipment to comply with applicable safety regulations. Further, Provide all material, labor and equipment to comply with reasonable or generally accepted safety precautions as directed by the Owner or the Architect.

B. Comply with all of the safety requirements of OSHA throughout the entire construction period of the project.

C. Furnish, place and maintain proper guards for prevention of accidents and any other necessary construction required to secure safety of life and property.

D. Perform work only in areas of the building as approved by the Owner or his representative. Personnel and equipment access to the site, lay down areas, parking areas and areas of work shall only be as designated and allowed by the Owner.

1.22 WELDING QUALIFICATIONS

A. Weld in accordance with qualified procedures using performance qualified welders and welding operators. Procedures and welders shall be qualified in accordance with ASME BPV IX. Welding procedures qualified by others, and welders and welding operators qualified by another employer may be accepted as permitted by ASME B31.1. The Owner shall be notified 24 hours in advance of tests and the tests shall be performed at the work site if practicable. The welder or welding operator shall apply his assigned symbol near each weld he makes as a

permanent record. Structural members shall be welded in accordance with SECTION 051200-STRUCTURAL STEEL.

B. A fire watchman with an approved fire extinguisher shall be posted at the site of the welding work, during that work, and for a minimum of 30 minutes after the work is completed, to see that sparks or drops of hot metal do not start fires.

1.23 SCHEDULE

A. Construct work in sequence under provisions of General Conditions.

1.24 SPARE PARTS

A. The HVAC Subcontractor shall furnish spare-parts data for each different item of equipment furnished

B. The HVAC Subcontractor shall furnish a minimum of 4 additional complete sets of filters for all air handling equipment using filters. In addition to the filters furnished with each piece of equipment from the manufacturer, the HVAC Subcontractor shall provide two complete sets of filters to be used during the construction and then the testing and balancing period.

1.25 MAINTENANCE ACCESSORIES AND TOOLS

A. All special tools necessary as recommended by the equipment manufacturer(s) for the operation and maintenance of boilers, pumps, fans, and other equipment shall be furnished. Small hand tools shall be furnished with a suitable lockable cabinet, mounted where directed.

B. Special Wrenches

1. Special wrenches shall be provided as required for opening boiler manholes, hand holes, and cleanouts.

1.26 SEALING

A. All penetrations through the structure shall be sealed air and water tight where required for acoustical reason or where penetrating a fire rated element must be firestopped. This contractor shall coordinate all penetrations of the floors and ceiling with G.C. Fire Stopping requirements is under section 078400.

1.27 SLEEVES, INSERTS AND ANCHOR BOLTS

A. Coordinate with other trades the location of and maintaining in proper positions, sleeves, inserts and anchor bolts to be supplied and/or set in place under this Section of the specifications. In the event of incorrectly located preset sleeves, inserts and anchor bolts, etc., all required cutting and patching of finished work shall be done under this Section of the specifications.

B. Unless otherwise specified herein, all pipes passing through floors, walls, ceilings or partitions shall be provided with sleeves and rating shall be maintained of fire stopping.

C. Field drilling (core drilling), when required, shall be performed under this Section of the specifications, after receipt of approval by the General Contractor.

1. When coring can not be avoided, provide ¼-inch pilot hole prior to coring. When coring through floor or slab, verify location of core on floor below and protect and piping, ductwork, wiring, personnel, etc., below the location of the core.

1.28 SUPPLEMENTARY STEEL, CHANNELS AND SUPPORTS

A. Provide all supplementary steel, factory fabricated channels and supports required for proper installation, mounting and support of all equipment and systems provided under this Section of the specification.

B. Supplementary steel and factory fabricated channels shall be firmly connected to building construction in a manner approved by the General Contractor, as shown on the drawings, or hereinafter specified.

C. The type and size of the supporting channels and supplementary steel provided under this Section of the specifications shall accommodate all deflections in conformance with the manufacturer's requirements for the specific loading on the system installed therein.

D. All supplementary steel and factory fabricated channels shall be installed in a neat and workmanlike manner parallel to the walls, floors and ceiling construction. All turns shall be made with 90 degree and 45 degree fittings, as required to suit the construction and installation conditions.

E. All supplementary steel including factory fabricated channels, supports and fittings shall be UL approved, shall be galvanized steel where exposed or subject to rust producing atmosphere and shall be manufactured by Unistrut, H-strut, Powerstrut or approved equal.

1.29 ACCESSIBILITY

A. All work provided under this Section of the Specification shall be installed so that parts requiring periodic inspection, maintenance and repair are readily accessible. Minor deviations from the drawings may be made to accomplish this, but changes of substantial magnitude shall not be made prior to written approval from the General Contractor.

B. All piping runs and valve locations shall be coordinate with plumbing and fire protection piping to permit shut off and isolation of piping shall occur from one location with common access panel.

1.30 TESTING AND BALANCING

A. General Requirements

The Contractor shall select AABC MN-1, NEBB-01, SMACNA-07 or ASHRAE 111 as the standard for providing testing, adjusting and balancing of air and water systems. The selected standard shall be used throughout the project. Testing, adjusting, and balancing shall be accomplished by a firm certified for testing and balancing by Associated Air Balance Council (AABC) or National

Environmental Balancing Bureau (NEBB). Prior to testing, adjusting, and balancing, the Contractor shall verify that the systems have been installed and are operating as specified. Approved detail drawings and all other data required for each system and/or component to be tested shall be made available at the job site during the entire testing, adjusting and balancing effort. The Contractor shall verify that all balancing devices are properly installed to permit testing, adjusting and balancing and that all duct leakage tests have been completed prior to testing, adjusting and balancing. The Owner's Representative shall be notified in writing of all equipment, components, or balancing devices, that are damaged, incorrectly installed, or missing, as well as any design deficiencies that will prevent proper testing, adjusting, and balancing. Testing, adjusting, and balancing shall not commence until approved by the Owner's Representative. Instrumentation accuracy shall be in accordance with the standard selected in this paragraph. Sound level measuring equipment shall be rated in accordance with ANSI S1.4 and ANSI S1.11.

The Final position of each balancing valve and damper shall also be physically marked with permanent marker.

B. Instrument Accuracy Requirements

All instrumentation shall be checked for accuracy before beginning testing, adjusting and balancing procedures. Instrument accuracy shall be in accordance with the standard selected in Paragraph A. General Requirements, immediately above. Checks may be carried out against similar equipment maintained specifically for checking purposes or by the manufacturer or a recognized testing facility. All instrumentation used for testing shall be calibrated within 6 months of use. Pitot tubes and U-tube manometers do not require checking. In no case shall the instrumentation accuracy be less than specified by the instrument manufacturer. Any instrument falling out of calibration during the process of balancing and testing shall be recalibrated or removed from the site and replaced by a properly calibrated instrument. No instruments shall be allowed to remain on-site that are not in calibration.

C. Submittals

1. List the minimum data to be included in the final balance report.

   The following shall be submitted in accordance with Section 01300-Submittals.

2. Reports:

   Testing and Balancing; 6 copies of a preliminary report, 30 days before balancing commences. The report shall be organized by specific systems and shall clearly identify each item of equipment to be tested, adjusted, and balanced.

   All instruments that are recalibrated and brought back onto the job site after being found to be out of calibration shall have recalibration records submitted on forms shown in AABC MN-1 or SMACNA-07.

3. Certificates

Qualification: Qualification data, 90 days prior to testing and balancing operations. The test and balance firm shall be certified by the Associated Air Balance Council (AABC) or the National Environmental Balancing Bureau (NEBB). The lead balancing technician shall be qualified by AABC or NEBB and his qualification data shall include past experience on at least five similar projects.

1.31 CERTIFICATES OF INSPECTION/APPROVAL

A. Furnish upon completion of all work, certificates of inspections from the manufacturers stating that authorized factory engineers have inspected and tested the operation of their respective equipment and found same to be in satisfactory operating conditions.

PART 2 – PRODUCTS

2.01. INSULATION

A. Materials shall be compatible and shall not contribute to corrosion, soften, or otherwise attack surfaces to which applied in either the wet or dry state. Materials to be used on stainless steel surfaces shall meet ASTM C 795 requirements. Materials shall be asbestos free and conform to the following:

1. General: The fire hazard rating of all insulation related materials shall not exceed 25 for flame spread and 50 for fuel contributed and smoke developed as determined by UL723 “Test for surface burning characteristics of building materials”, NFPA 225 or ASTM E84.

B. Adhesives

1. Acoustical Lining Insulation Adhesive

Insulation shall be applied in cut-to-size pieces attached to the interior of the duct with a nonflammable, fire-resistant adhesive conforming to ASTM C 916, Type I, NFPA 90A, UL 723, and ASTM E 84.

2. Mineral Fiber Insulation Cement

Cement shall be in accordance with ASTM C 195.

3. Contact Adhesive

Adhesive shall be Type II, Class 1.

4. Lagging Adhesive

Lagging adhesives shall be nonflammable, fire-resistant in accordance with NFPA 90A, UL 723, and ASTM E 84. Adhesives shall be either the Class 1 or Class 2 type. .

5. Contact Adhesive

The adhesive shall be nonflammable, fire resistant conforming to ASTM E 84.

C. Caulking: ASTM C 920, Type S, Grade NS, Class 25, Use A.

D. Corner Angles: nominal 0.016-inch aluminum 1-inch by 1-inch with factory applied Kraft backing. Aluminum shall be ASTM B 209, Alloy 3003, 3105, or 5005.

E. Finishing Cement: mineral fiber hydraulic-setting thermal insulating cement ASTM C 449.

F. Glass Tape: Glass tape shall meet the requirements of UL 723 and ASTM E 84.

G. Staples

Outward clinching type ASTM A 167, Type 304 or 316 stainless steel.

H. Jackets

ASTM C 921, Type I, moisture vapor transmission maximum 0.02 perms, puncture resistance minimum 50 Beach units on all surfaces except concealed ductwork, where a minimum puncture resistance of 25 Beach units is allowable, tensile strength minimum 35 pound/inch width; Polyvinyl chloride (PVC) jacket and fitting covers shall be FS L-P-535, Composition A, Type II, with minimum thickness 0.030-inch. Insulation under PVC jacket shall meet jacket manufacturer's written recommendations.

I. Vapor Barrier Coating

The vapor barrier coating shall be fire and water-resistant and appropriately selected for either outdoor or indoor service.

J. Weather and Vapor Barrier Coating for outdoot duuctwork

1. Provide a rubberized bitumen coating, laminated to an aluminum coated high strength polyethylene film. Coating shall ultraviolet light resistant, and shall be chemical-resistant to acids, salts and bases.
2. Coating film shall be a minimum 4.0 mils thick, and the total coating shall be a minimum 60.0 mils thick.
3. Water vapor transmission shall be in accordance with ASTM E 96 B, 0.014 U.S. Perms.
4. Peel Adhesion shall be at least 15.0/lbs./inch width.
5. Tensile strength of the film shall be at least 5000-psi, in accordance with ASTM D 882 Method B.
6. Coating shall not be caused to crack at exposure to -15 degrees F.

K. Duct Insulation

1. General

a) Insulation shall be John Manville, Certain-Teed, Knauf, or Owens Corning. Install insulation, mastics, adhesives, coatings, covers, weather-protection and other work exactly as required by manufacturer's recommendations. Materials shall meet requirements of Adhesive and Sealant Council Standards and SMACNA.

b) Duct Insulation shall conform to the IMC section 604. Apply insulation after systems have been tested, proved tight and approved by Engineer. Remove dirt, scale, oil, rust and other foreign matter prior to installation of insulation.

c) Leaks in vapor barrier or voids in insulation will not be accepted.
d) ASTM E-84 minimum fire hazard ratings shall be 25 flame spread, 50 fuel contributed and 50 smoke developed.
e) Where ducts are insulated, flexible connections to ducts shall be insulated.

f) Insulate standing seams with same material and thickness as duct.
g) Ductwork having internal lining may still requires exterior insulation to allow for proper insulation R value.
h) Insulation shall be continuous through wall and ceiling openings and in sleeves.
i) Transmission rates of vapor barriers shall not exceed 0.02 perms.

2. Concealed Ductwork

a) Supply and return air ductwork from RTU's, Outside air intake shall be insulated with 2-1/5" thick fibrous glass duct wrap, with foil kraft flame resistant vapor barrier.

b) Insulation density shall be 3/4 lb/cf and maximum K-factor shall be 0.27 at 75° F mean temperature and per ASTM C518. Insulation shall be equal to Johns Manville "Microlite FSK" Type 75 with installed R value of 6.

c) If insulation does not have precut lap make lapped, butt joints by cutting 2" strip of insulation away from vapor barrier. Apply 6" strips of approved adhesive on 16" centers and wrap duct with insulation. Staple lapped joint with outward-clinching staples. Seal stapled joints airtight with approved vapor barrier mastic or pressure-sensitive tape.
d) For rectangular duct 24" or larger in any dimension, augment application method specified in item 3 with approved mechanical fasteners, such as weld pins with speed washers, on 18" centers on bottom of duct.
e) Cover breaks in vapor material with patches of same material, secured with adhesive and staples. Seal staples with approved vapor barrier coating.
f) Fill voids in insulation at jacket penetrations and seal with vapor barrier coating.
g) Seal and flash terminations and punctures with fibrous glass cloth between two coats of vapor barrier coating.
h) Terminate vapor barrier and extend insulation at standoff brackets.

3. Duct Liner

a) Flexible Elastomeric Duct Liner: Preformed glass fibers bonded with a thermosetting resin, sheet materials complying with ASTM C 1071, Type I; and with NFPA 90A or NFPA 90B. The air stream surface shall be factory coated with reinforced coating system of acrylic coating and flexible glass mat. Edges of the liner shall be factory sealed. Cut edges shall be treated with an additional edge treatment recommended by the manufacturer. Duct Liner shall be equal to Johns Manville "Linacoustic RC".

b) Provide 1.5" thick duct liner for the first 10 feet of all of ductwork connected to RTU's and air handling units,.

2.02. VARIABLE FREQUENCY DRIVES

A. The Variable Frequency Drive (VFD) specified shall be designed to control motor operating with a rated input voltage of 208V, 3-phase, 60 Hz. The VFD shall provide smooth and efficient motor control by modulating the output frequency over a range of 0 to 60 Hz and shall maintain an efficiency of at least 97% at full load. The VFD shall be capable of operating under overload conditions up to 110% of its rated current for 60 seconds. VFDs will be installed with 3% line reactors and manual bypass. Compliance with industry standards, the VFD shall meet or exceed IEEE 519 requirements for harmonic distortion.

B. Acceptable Manufacturers:

1. Toshiba
2. ABB
3. Siemens
4. Yaskawa

C. The VFD shall offer advanced control features, including PID control for process feedback, adjustable acceleration and deceleration ramps, and remote/local operation capability. The control interface shall include a keypad with an LED or LCD display for real-time monitoring and configuration. Communication protocols such as Modbus RTU or TCP/IP shall be standard, with optional support for BACnet, Profibus, or Ethernet/IP. Comprehensive motor protection features, including overload, overvoltage, undervoltage, and phase loss protection, shall be incorporated to ensure reliability and safety

D. The VFD shall be housed in a robust enclosure rated for the installation environment, such as NEMA 1 for indoor use or NEMA 3R for outdoor applications. The construction shall utilize corrosion-resistant materials, and the cooling system shall employ forced air or passive heat dissipation as required. Accessories such as line reactors or input filters to reduce harmonics and output filters for long motor lead applications shall be provided as needed. For enhanced operational flexibility, a bypass option for manual motor control during VFD failure may be included.

E. Installation of the VFD shall adhere to the manufacturer’s guidelines and applicable codes. Proper ventilation and clearances around the unit must be maintained to ensure optimal performance and ease of maintenance. Field testing shall include verification of input and output ratings, grounding, motor operation under load, and validation of all control and safety functions. The VFD shall be factory-tested prior to shipment, and a warranty of at least 12 months from commissioning or 18 months from shipment shall be provided.

F. The supplier shall submit all necessary documentation, including product data, installation manuals, and factory test reports, for review and approval prior to installation. Upon completion, training on operation, maintenance, and troubleshooting shall be provided to the owner’s personnel. Start-up and commissioning shall be conducted in the

presence of the owner's representative, and a detailed commissioning report shall be submitted.

2.03. DUCTWORK

A. Metal Ductwork

All aspects of metal ductwork construction, including all fittings and components, shall comply with THE SMACNA HVAC DUCT CONSTRUCTION STANDARDS, 2ND ED., 1995 unless otherwise specified. Elbows shall be radius type with a centerline radius of 1-1/2 times the width or diameter of the duct where space permits or unless noted otherwise. Otherwise, elbows having a minimum radius equal to the width or diameter of the duct or square elbows with factory fabricated turning vanes may be used. Static pressure Class ½ and 1-inch WG ductwork shall meet the requirements of Seal Class C. Class 2-inch WG ductwork shall meet the requirements of Seal Class B. Class 3 through 10-inch WG shall meet the requirements of Seal Class A. Pressure sensitive tape shall not be used as a sealant. Spiral lock seam duct, and flat oval shall be made with duct sealant and locked with not less than 3 equally spaced drive screws or other approved methods indicated in THE SMACNA HVAC DUCT CONSTRUCTION STANDARDS, 2ND ED., 1995. The sealant shall be applied to the exposed male part of the fitting collar so that the sealer will be on the inside of the joint and fully protected by the metal of the duct fitting. One brush coat of the sealant shall be applied over the outside of the joint to at least 2-inch band width covering all screw heads and joint gap. Dents in the male portion of the slip-fitting collar will not be acceptable. Outdoor air intake ducts and plenums shall be fabricated with watertight soldered or brazed joints and seams.

1. Rectangular ductwork schedules:

SCHEDULE OF RECTANGULAR DUCTWORK CONSTRUCTION (UP TO 2-inch WG)

Duct Dimension (inches)	Metal gages		Transverse joint construction	Reinforcement spacing	Transverse joint Reinforcement
	Galvanized steel	B & S aluminum			
<=12	24	0.040"	1" pocket lock	---	None
13-18	24	0.040"	Standing "S" slip	8'-0"	1"x26 gauge
19-26	22	0.050"	Standing "S" slip	8'-0"	1"x26 gauge
27-30	20	0.064"	Standing "S" slip	8'-0"	1"x24 gauge

2. Round:

a. Round ductwork shall be furnished where shown or called for on the drawings, and may be substituted for rectangular, as an option to the Sheet Metal Sub-subcontractor when approved by

the engineer, and shall be provided where shown on the Drawings.

b. Round duct and fittings shall be of spiral lock seam construction and shall be fabricated from G-60 galvanized steel or 316 stainless steel. Galvanized steel shall meet ASTM A525 & A527 standards and stainless steel shall meet ASTM A240 and shall be fabricated in accordance with the following table.

SCHEDULE OF ROUND DUCTWORK CONSTRUCTION						
Duct Diameter (inches)	0.0" to +10.0" WG		0.0" to -10.0" WG (Class B)			
	Galvanized		Galvanized		316 Stainless Steel	
	Ductwork	Fittings	Ductwork	Fittings	Ductwork	Fittings
3-8	26	22	24	20	24	20
9-14	26	22	22	18	22	18

3. Transitions

Diverging airflow transitions shall be made with each side pitched out a maximum of 15 degrees, for an included angle of 30 degrees. Transitions for converging airflow shall be made with each side pitched in a maximum of 30 degrees, for an included angle of 60 degrees, or shall be as indicated. Factory-fabricated reducing fittings for systems using round duct sections when formed to the shape of the ASME short flow nozzle, need not comply with the maximum angles specified.

4. Metallic Flexible Duct

Metallic type duct shall be single-ply galvanized steel. Duct shall be of corrugated/interlocked, folded and knurled type seam construction, bendable without damage through 180 degrees with a throat radius equal to 1/2 duct diameter. Duct shall conform to UL 181 and shall be rated for positive or negative working pressure of 15-inches water gauge at 350 degrees F when duct is aluminum, and 650 degrees F when duct is galvanized steel or stainless steel.

5. General Service Duct Connectors

A flexible duct connector approximately 6-inches in width shall be provided where sheet metal connections are made to fans or where ducts of dissimilar metals are connected. For round/oval ducts, the flexible material shall be secured by stainless steel or zinc-coated, iron clinch-type draw bands. For rectangular ducts, the flexible material locked to metal collars shall be installed using normal duct construction methods. The composite connector system shall comply with UL 214 and be classified as "flame-retarded fabrics" in UL-01.

B. Ductwork Accessories

1. Access Doors in ductwork up to 2-inch pressure class.

   a. Frame: 24 gage galvanized steel with seal

   b. Door: hinged, with 24 gage galvanized steel exterior and interior panels.

   c. Locks: doors 16" and under, one lock doors over 16", two locks

   d. Seals: foam gasket

   e. Insulation: ½-inch foam board with aluminum foil face, 0.12K at 75°F.

   f. Ruskin Model ADH-2, Inland Steel, Miami-Carey or approved equal.

2. Splitters and Manual Volume Dampers

   Manual volume dampers shall be provided where shown on the Drawings at every branch take off from the main duct, and elsewhere as required by the Balancing Sub-subcontractor, and shall be single or multiple blade type with sleeve bearings, galvanized steel interlocking blades and a galvanized steel frame. In ducts over 15" deep provide multiple opposed blade type, gang operated dampers with a maximum blade width of 8". Damper blades shall be fabricated of 16-gauge steel with hemmed edges, and a maximum length of 48". Damper operating rod shall be full blade length extended through the duct to externally mounted bearing plates. On insulated ductwork, bearing plates shall be installed flush with insulation finish and fastened to the duct. Operating lever shall be of the indicating type with locking quadrant.

3. Backdraft Dampers

   Back draft dampers shall be provided where indicated and required, and shall consist of a set of externally adjustable counter weighted louvers that open automatically due to excess pressure and prevent reverse flow. The edges of the blades shall be provided with seals to prevent rattling and minimize air leakage. The damper blades shall be supported on metal frames designed for wall mounting as indicated. The dampers shall be rated for operation up to a minimum of 2,500 fpm, standard catalog products of Ruskin, Vent Products, American Warming and Ventilating or approved equal.

4. Automatic Control Air Dampers:

   a. Furnish and install low leakage automatic control aluminum dampers including necessary linkages, supports, actuators, switches, etc.

5. Blank off Plates

Any blank off plates or conversions required for mounting control dampers or coils shall be the responsibility of the Sheet Metal Sub-subcontractor.

6. Insulated Metal Panels

Provide 18-gauge, insulated double wall sandwich construction, 1½" thick where called for on the Drawings and for blanking off unused portions of wall louvers.

7. Flexible connections shall be 6" wide connections constructed of heavy glass fabric double coated with neoprene. Flexible connections shall meet the requirements of the National Board of Fire Underwriters.

C. Duct Sleeves, Framed Prepared Openings, Closure Collars

1. Duct Sleeves

Duct sleeves shall be provided for round ducts 15-inches in diameter or less passing through floors, walls, ceilings, or roof, and installed during construction of the floor, wall, ceiling, or roof. Round ducts larger than 15-inches in diameter and square, rectangular, and oval ducts passing through floors, walls, ceilings, or roof shall be installed through framed prepared openings. The Contractor shall be responsible for the proper size and location of sleeves and prepared openings. Sleeves and framed openings are also required where grilles, registers, and diffusers are installed at the openings. Framed prepared openings shall be fabricated from 20-gauge galvanized steel, unless otherwise indicated. Where sleeves are installed in bearing walls or partitions, black steel pipe, ASTM A 53, Schedule 20 shall be used. Sleeve shall provide 1-inch clearance between the duct and the sleeve or 1-inch clearance between the insulation and the sleeve for insulated ducts.

2. Framed Prepared Openings

Openings shall have 1-inch clearance between the duct and the opening or 1-inch clearance between the insulation and the opening for insulated ducts.

3. Closure Collars

Collars shall be fabricated of galvanized sheet metal not less than 4-inches wide, unless otherwise indicated, and shall be installed on exposed ducts on each side of walls or floors where sleeves or prepared openings are provided. Collars shall be installed tight against surfaces. Collars shall fit snugly around the duct or insulation. Sharp edges of the collar around insulated duct shall be ground smooth to preclude tearing or puncturing the insulation covering or vapor barrier. Collars for round ducts 15-inches in diameter or less shall be fabricated from 20-gauge galvanized steel. Collars for round ducts larger than 15-inches and square, and rectangular ducts shall be fabricated from 18-gauge galvanized steel. Collars shall be installed with fasteners on maximum 6-inch centers, except that not less than 4 fasteners shall be used.

2.04. VEHICLE UTILITY EXHAUST FAN- (VEF)

A. General

1. Each fan shall be belt drive in AMCA arrangement 10 according to drawings. Acceptable manufacturers are Greenheck, Loren Cook, Monovent or equal.
2. Normal operating temperature up to 180 Degrees Fahrenheit.
3. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model and individual serial number.
4. Fans are to be equipped with lifting lugs.
5. Constructed of heavy gauge steel
6. After fabrication, untreated steel components go through a multi-stage cleaning and pre-treatment process before being finished with a high-performance powder coating having a minimum thickness of 2-4 mils, electrostatically applied and baked. Finish color shall be RAL-7023, concrete grey. Coating must exceed 1,000-hour salt spray under ASTM B117 test method. No uncoated metal fan parts will be allowed.

B. Fan Housing

1. Fan housing is to be aerodynamically designed with high-efficiency inlet, engineered to reduce incoming air turbulence.
2. Fan shall be of airtight construction with the scroll panel material formed and embedded into the side panels continuously welded heavy gauge scroll construction. All interior and exterior surface untreated steel shall be coated with a high-performance powder coating.
3. Housing and bearing support shall be constructed of bolted framework
4. An OSHA compliant shaft guard shall be included to completely cover the shaft for arrangement 8 only.

C. Fan Wheel

1. The fan wheel shall be of the single width backward inclined centrifugal type.
2. Fan Wheel shall be statically and dynamically balanced to balance grade G6.3 per ANSI S2.19.
3. The wheel and fan inlet shall be carefully matched and shall have precise running tolerances for maximum performance and operating efficiency.

D. Fan Motors and Drive

1. Motors shall meet or exceed EISA (Energy Independence and Security Act) efficiencies. Motors to be NEMA T-frame, 690, 870, 1170, 1770 or

3500 RPM in 60 Hz, (720, 950, 1425 or 2900 in 50 Hz) Open Drip Proof (ODP) or Totally Enclosed Fan Cooled (TEFC).

E. Support Curb

Provide equipment support Curb

2.05. VEHICLE EXHAUST SYSTEM COMPONENTS

A. Exhaust Hose

1. The Exhaust Hose equals Plymovent vehicle exhaust systems ET. Other approved manufactures are Fume-A- Vent, Car-Mon or equal.
2. The hose shall be designed to extract hazardous fumes generated by gasoline and diesel engines, The product shall be made up of a hiqh-quality fabric composite hose that can endure exhaust gas temperatures of up to 1110°F (600°C) and to be suitable for heavy vehicles.
3. The hose shall be 32 ft. 8” diameter.

B. Hose Accessories

1. Metal Saddles to maneuver and strength hose as required.
2. Splice Collars to join the connection
3. Recoil Balancer- to hold the hose up of the floor when not in use. Provide and ratchet lock to hold the cable at the extended position when the hose is in use.
4. Nozzles stainless steel cone nozzles for high temperature for vertical stack tailpiece. Include spring clips, vise grips for attachment.

2.06. ROOF MOUNTED VENTILATION EXHAUST FAN

A. General Description:

1. Discharge air directly away from the mounting surface
2. Upblast fan shall be for roof mounted applications and acceptable manufacturer are Greenheck, Loren Cook, Barry Blower or equal
3. Performance capabilities up to 14,700 cubic feet per minute (cfm) and static pressure to 3 inches of water gauge
4. Fans are available in twenty-two sizes with nominal wheel diameters ranging from 9 inches through 30 inches (060 - 300 unit sizes)
5. Maximum continuous operating temperature for fan sizes 098-300 is 400Fahrenheit (204.4 Celsius) and for fan sizes 060-095 is 130 Fahrenheit(54.4 Celsius)

6. Each fan shall bear a permanently affixed manufacture's engraved metal nameplate containing the model number and individual serial number

B. Wheel

1. Material type: aluminum
2. Non-overloading, backward inclined centrifugal
3. Statically and dynamically balanced in accordance to AMCA Standard 204-05
4. The wheel cone and fan inlet will be matched and shall have precise running tolerances for maximum performance and operating efficiency.

C. Motor

1. AC Induction Motor Open drip-proof enclosures
2. Motors are permanently lubricated, heavy duty ball bearing type to match with the fan load and furnished at the specific voltage and phase on fan sizes 90 and larger. Fan sizes 60-80 use sleeve bearing.
3. Mounted on vibration isolators, out of the airstream
4. For motor cooling there shall be fresh air drawn into the motor compartment through an area free of discharge contaminants
5. Accessible for maintenance

D. Housing

1. Constructed of heavy gauge aluminum includes exterior housing, curb cap, windband, and motor compartment housing. Galvanized material is not acceptable.
2. Housing shall have a rigid internal support structure. Windband to be one piece uniquely spun aluminum construction and maintain original material thickness throughout the housing.
3. Windband to include an integral rolled bead for strength.
4. Curb cap base to be fully welded to windband to ensure a leak proof construction. Tack welding, bolting, and caulking are not acceptable.
5. Curb cap to have integral deep spun inlet venturi and pre-punched mounting holes to ensure correct attachment to curb.
6. Drive frame assemblies shall be constructed of heavy gauge steel and mounted on vibration isolators.
7. Breather tube shall be 10 square inches in size for fresh air motor cooling and designed to allow wiring to be run through it.

E. Motor cover shall be constructed of aluminum

F. Disconnect Switch shall be NEMA -3R.

G. Drain Trough shall allow one point drainage of water.

H. Birdscreen shall be constructed of stainless.

I. Provide minimum 18” high roof curb

2.07. DIFFUSERS, REGISTERS AND GRILLES

A. Acceptable manufacturer’s: Price, Tuttle and Bailey, Titus or Price.

B. Registers and Grilles: Units shall be four-way directional-control type, except that return and exhaust registers may be fixed horizontal or vertical louver type similar in appearance to the supply register face. Registers shall be provided with sponge-rubber gasket between flanges and wall or ceiling. Wall supply registers shall be installed at least 6 inches below the ceiling unless otherwise indicated. Return and exhaust registers shall be located 6 inches above the floor unless otherwise indicated. Four-way directional control may be achieved by a grille face which can be rotated in 4 positions or by adjustment of horizontal and vertical vanes. Grilles shall be as specified for registers, without volume control damper.

2.08. HEATING AND COOLING AIR HANLING UNIT (AHU-1)

A. Gneral

1. Packaged Air conditioning unit cooling capacities, heating capacities, and efficiencies are certified to the following standards:
   3 to 5 ton units: AHRI Standard 210/240.
2. Gas Heating Units: ANSI Z21.47 and 10 CFR Part 431 for Commercial Warm Air.
3. Convertible airflow.
4. Controls operating range between 40°F and 125°F in cooling mode standard from the factory. Field-installed low ambient kit extends operating range down to 0°F.
5. Factory assembled, internally wired, fully charged, and 100 percent run tested to verify cooling operation, fan and blower rotation, and control sequence.
6. Colored and numbered wiring internal to the unit for simplified identification.
7. cULus listed and classified in accordance for Central Cooling Air Conditioners.
8. Unit shall be furnished with a leak detection system from the fact

B. Unit Casings

1. General Fabrication Requirements for Casings:

   a. Zinc coated, heavy gauge, galvanized steel.
   b. Weather resistant pre-painted metal with galvanized substrate.
   c. Meets ASTM B117, 672 hour salt spray test.
   d. Removable single side maintenance access panels.
   e. Lifting handles in maintenance access panels (can be removed and reinstalled by removing fasteners while providing a water and air tight seal).

f. Exposed vertical panels and top covers in the indoor air section insulated with a cleanable foil-faced, fire-retardant permanent, odorless glass fiber material.
g. Base pan shall have no penetrations within the perimeter of the curb other than the raised 1 inch high downflow supply/return openings to provide an added water integrity precaution, if the condensate drain backs up.
h. Base of the unit insulated with 1/8 inch, foil-faced, closed-cell insulation.
i. Unit base provisions for forklift and/or crane lifting on three sides of unit.

2. Hail Guards:
   a. Provides condenser coil protection

3. Stainless Steel Drain Pan
   a. Corrosion and oxidation resistance.
   b. Constructed of 304 stainless steel

4. Microchannel Coils
   a. Optimal heat transfer performance due to flat, streamlined tubes with small ports, and metallurgical tube-to-fin bond.
   b. Reduce system refrigerant charge by up to 50% leading to better compressor reliability.
   c. Compact all-aluminum microchannel coils reduce the unit weight.
   d. Recyclable all aluminum coils All aluminium construction minimizes galvanic corrosion.
   e. Strong aluminum brazed structure provides better fin protection.
   f. Flat streamlined tubes more dust resistant and easy to clean.
   g. Coils leak tested at the factory to ensure the pressure integrity.

5. Compressors
   a. All units have direct-drive, hermetic, scroll type compressors with centrifugal type oil pumps.
   b. Suction gas-cooled motor with voltage utilization range of plus or minus 10 percent of unit nameplate voltage.
   c. Internal overloads standard with scroll compressors.
   d. Three stages of cooling.
6. Filters
   a. Two inch standard filters shall be factory supplied on all units.
7. Frostat
   a. Utilized as a safety device.
   b. Opens to prevent freezing temperatures on evaporator coil.
   c. Temperature will need to rise to 50°F before closing.

8. Gas Heating Section
   a. The heating section shall have a progressive tubular heat exchanger with corrosion-resistant aluminized steel tubes and burners as standard on all models.

b. Stainless steel heat exchanger with 409 stainless steel tubes and 439 stainless steel burners shall be optional.
c. Induced draft combustion blower shall be used to pull the combustion products through the firing tubes.
d. Heater shall use a direct spark ignition (DSI) system.
e. On initial call for heat, the combustion blower shall purge the heat exchanger for 20 seconds before ignition.
f. After three unsuccessful ignition attempts, entire heating system shall be locked out until manually reset at the thermostat/zone sensor.
g. Units shall be suitable for use with natural gas or propane (field-installed kit).

9. Indoor Fan

a. Plenum fan design - backward-curved fan wheel along with an external rotor direct drive variable speed indoor motor.
b. Supply fan speed adjustments can be made using the Symbio 700 or Mobile App.
c. Motors are thermally protected.
d. Variable speed direct drive motors are high efficiency - 6 to 25 tons.

10. Heat Exchanger
a. Compact cabinet features a tubular heat exchanger in low, medium and high heat capacities.
b. Corrosion-resistant aluminized steel tubes and burners are standard on all models.
c. Induced draft blower to pull the gas mixture through the burner tubes.
d. Direct spark ignition and a flame sensor as a safety device to validate the flame.

11. Economizer (Standard)
a. Available with or without barometric relief.
b. Fully modulating 0-100 percent motor and dampers, minimum position setting, preset linkage, wiring harness with plug, spring return actuator and fixed dry bulb control.
c. Barometric relief shall provide a pressure operated damper that shall be gravity closing.
d. Barometric relief shall prohibit entrance of outside air during the equipment ?off? cycle.
e. Optional solid state or differential enthalpy control.
f. Arrives in shipping position and shall be moved to the operating position by the installing contractor.

12. Reference or Comparative Enthalpy

a. Reference enthalpy used to measure and communicate outdoor humidity.

b. Unit receives and uses information to provide improved comfort cooling while using the economizer.
c. Comparative enthalpy measures and communicates humidity for both outdoor and return air conditions, and return air temperature.
d. Unit receives and uses information to maximize use of economizer cooling, and to provide maximum occupant comfort control.
e. Reference or comparative enthalpy available when a factory or field installed downflow economizer ordered.

2.09. HEATING AIR HANLING UNIT (AHU-2)

A. The HVAC section shall includes Fan units with integral Indirect Gas-Fired heating for outdoor installation. Airflow arrangement shall be outdoor air with recirculation. Each unit shall be constructed in a horizontal configuration and shall incorporate additional product requirements as listed in Section 2 of this specification.

B. Acceptable Manufacturer are Greenheck, Reznor, Modine, Trane or equal

C. Unit with Integral Heating be fully assembled at the factory and consist of an insulated metal cabinet, outdoor air intake weatherhood with aluminum mesh filter with bird screen with combination mesh filter and louver, intake damper and motorized recirculating damper, sensors, service receptacle, freeze protection, filter assembly for intake air, supply air blower assembly and an electrical control center. All specified components and internal accessories factory installed and tested and prepared for single-point high voltage connection.

D. Cabinet Materials: Formed, double wall insulated metal cabinet fabricated to permit access to internal components for maintenance. Underside of unit shall have formed metal panels covering base panel insulation.

1. Outside casing: 18 gauge, galvanized (G90) steel meeting ASTM A653 for components that do not receive a painted finish. Pre-painted components as supplied by the factory shall have polyester urethane paint on 18 gauge G60 galvaneal steel. Base rail is 12 gauge, galvazined (G90) steel. Components that receive a painted finish per A/E specification shall be of 18 gauge type A60 galvaneal steel and shall be painted with a baked industrial enamel finish]. [Components that receive a painted finish per A/E specification shall be painted with a polyester urethane powder coat].

2. Internal assemblies: 24 gauge, galvanized (G90) steel except for motor supports which shall be minimum14 gauge galvanized (G90) steel.

E. Cabinet Insulation: Comply with NFPA 90A and NFPA 90B and erosion requirements of UL

1. Materials: Fiberglass insulation. If insulation other than fiberglass is used, it must also meet the Fire Hazard Classification shown below.
   a. Thickness: 1 inch
   b. Fire Hazard Classification: Maximum flame spread of 25 and smoke developed of 50, when tested in accordance with ASTM C 411.

F. Access panels: Unit shall be equipped with insulated hinged access panels to provide easy access to all major components. Access panels shall be fabricated of 18 gauge galvanized G90 steel. Removable access panels shall incorporate a formed drip edge.

G. Supply Air blower assembly: Blower assembly consists of an electric motor as specified by A/E and a belt driven, double width, and double inlet forward curve blower. Assembly shall be mounted on heavy gauge galvanized rails and further mounted on minimum 1.125 inch thick neoprene vibration isolators.

H. Control panel / connections: unit shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections.

I. Indirect Gas-Fired Furnace
   1. Shall be ETL Certified as a component of the unit.
   2. Shall have an integral combustion gas blower.
   3. Shall be ETL Certified for installation downstream of a cooling coil.
   4. Shall have fault sensors to provide fault conditions to optional digital controller or building controls.
   5. Shall have 4-pass tubular heat exchangers, constructed of type 409 stainless steel. Heat exchanger tubes shall be installed on the vest plate by means of swaged assembly, welded connections are not acceptable. Heat exchanger tubes shall be supported by a minimum of two fabricated assemblies that support the tubes and also permit expansion and contraction of the tubes.

J. Heat exchanger shall have a 5 year extended warranty.

K. Furnace control shall be electronic modulating type for supply temperature. Shall be encased in a weather-tight metal housing with intake air vents. Large, metal lift-off or hinged door shall provide easy access to the enclosed vest plate, control circuitry, gas train, burner assembly and exhaust blower.

L. The control shall have solid state controls permitting stand-alone operation

M. BLOWER

1. Blower section construction, Supply Air: Belt drive motor and blower shall be assembled onto a minimum 14 gauge galvanized steel platform and must have neoprene vibration isolation devices, minimum of 1-1/8 inches thick.
2. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.
3. Centrifugal blower housing: Formed and reinforced steel panels to make curved scroll housing with shaped cutoff.
4. Forward curved blower (fan) wheels: Galvanized or aluminum construction with inlet flange and shallow blades curved forward in direction of airflow. Mechanically attached to shaft with set screws.

N. Motor

1. General: Blower motors greater than ¾ horsepower shall be “NEMA Premium™” unless otherwise indicated. Compliance with EPAct minimum energy-efficiency standards for single speed ODP and TE enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished.

O. UNIT CONTROLS

1. Unit shall incorporate a DDC controller with integral LCD screen that provides text readouts of status, operating settings and alarm conditions. DDC controller shall have a built-in keypad to permit operator to access read-out screens and change settings without the use of ancillary equipment, devices or software. DDC controllers that require the use of equipment or software that is not factory-installed in the unit are not acceptable. Alarm readouts consisting of flashing light codes are not acceptable.
2. Variable Frequency Drive (VFD)] unit shall have factory installed variable frequency drives or modulation of the blower motors The VFDs shall be factory-programmed for unit-specific requirements and shall not require additional field programming to operate.
3. Sensors to be provided with the unit
    a. Room / Space Temperature Sensors]
    b. Heating Inlet Air Sensor]
    c. Dirty Filter Sensor

2.10. GAS FIRED INFRARED HEATERS (IRH-1 &2)

A. MANUFACTURERS
Acceptable Manufacturers:
1. Roberts-Gordon
3. Space-Ray

4. Superior Radiant Products

B. PERFORMANCE REQUIREMENTS

1. Fuel: Natural Gas or Propane

2. Type: Low-intensity, tubular radiant heater

3. Burner: Fully modulating gas valve with electronic ignition

4. Turndown Ratio: Minimum 1.5:1 modulation

5. Emissive Tube: Aluminized steel, minimum 16 gauge, with corrosion-resistant coating

6. Reflector: Polished aluminum or stainless steel, minimum 0.024” thick

7. Venting: Power vented, roof termination vent; comply with IMC and manufacturer guidelines

8. Controls: Hot surface ignition, safety shut-off, diagnostic LED, optional building automation interface. Modulating gas valve and hot surface electronic ignition control four-try, 100% shut-off, prepurge, post-purge, auto reset, tri-color led status/ fault indicator.

9. Mounting Height: As per manufacturer’s recommendations based on model selected

10. Clearance to combustibles: As required by manufacturer

11. Electrical requirements
    a. Voltage: 120V, 1 Phase, 60 Hz
    b. Current Draw: Maximum 5 Amps during ignition, 1.3 Amps operating
    c. Electrical control wiring to be in accordance with NEC and local code

2.11. FLUE VENT

A. Basis of Design: Selkirk Saf-T Vent Plus or equivalent UL 1738 listed Category III vent system. Other approved equals: Z-Flex, DuraVent or other UL 1738-listed product with prior approval.

B. Material

1. Type 444 or AL29-4C stainless steel (minimum 0.016" thick).

2. Suitable for flue gas temperatures up to 550°F continuous and 1400°F intermittent.

3. Tested for resistance to acidic condensate.
4. Optional outer wall insulation for reduced clearance to combustibles.
5. Joints:
    a. Self-sealing gasketed connections with positive locking bands.
6. Capable of operating under positive pressure (minimum 6" w.c. static pressure rating).

C. Fittings and Accessories

1. Factory-fabricated elbows, tees, cleanouts, drain fittings, supports, and firestop plates.
2. Condensate drain with trap and cleanout.
3. Vent terminations with appropriate wind/rain protection and UL listing.

D. Performance Requirements

1. System Pressure Rating: Positive pressure up to 6" w.c. minimum.
2. Temperature Rating: Continuous flue gas temperature up to 550°F.
3. UL 1738 Listed: System shall comply with all corrosive and pressure performance tests.

2.12. ROOF CURBS

A. As supplied by equipment manufacturer for roof mounted equipment. Provide pre-fabricated adjustable curbs for duct penetrations.

B. Provide roof curbs shall be minimum 16” high and shop-fabricated from 0.064-inch aluminum sheet with heliarc welded joints, integral cants, and flanges, and wood nailer. Sizes as indicated or as required for equipment.

C. Provide insulation liner of 1-1/2-inch minimum thickness glass fiber: NFPA 90A Standards, flame spread rating of 25 or less, smoke rating 50 or less; coated with neoprene or equal as protection from erosion.

D. Provide integral pipe chase for roof mounted air handlers with coils.

E. Rooftop Units shall have minimum 2” isolation base roof curb.

2.13. GAS DETECTION SYSTEM

A. The system shall be Honeywell, Macurco, Toxalert, or approved equal and shall be comprised of a control unit, a programmable relay module, addressable infrared gas detectors, initiating device circuits, notification appliance circuits, and analog initiating devices with control unit(s) communicating over a high speed fault tolerant communications link to form an integrated system.

B. All field devices shall have 3/4 inch NPT cable entry and separate terminals for incoming and outgoing field wiring. Terminals shall be sized to accept 16 to 22 AWG wire.

C. All detector locations shall permit the separation from the transmitter for a distance up to 50 feet for carbon monoxide and nitrogen dioxide detectors. Transmitters shall have the capability to simulate and adjust the output to compensate for line loss and allow field testing. Conduit and cabling between the detector and remote transmitter shall be rated for installation in hazardous locations. The transmitter shall display Gas Concentration and Alarm Status as a minimum.

D. The alarm devices shall be a combination horn and visual alarm. Alarm Horns shall operate on 24 VDC, provide 85 db at 10 ft, be corrosion resistant and be NEMA 4X rated. Visual Alarm shall operate on 24 VDC, provide 60 flashes per minute and be NEMA 4X rated.

E. Wire and cable shall be UL listed with color coded insulation appropriate for the area of installation. Cable shielding, conductor configuration and sizing shall be as recommended by the system manufacturer. All system wire and cabling installed outside of equipment enclosures and devices shall be installed in rigid galvanized steel conduit.

F. Provide grounding of system equipment and cable shielding as recommended by the system manufacturer. Grounding shall comply with IEEE 1100.

G. Local Control Panel (Basis of design Honewell Model VA301C)

1. The control panel must be capable of communicating digitally with the networked transmitters and relay modules through three RS-485 Modbus communication buses. Each communication bus must be capable of accepting a combination of up to 32 addressable transmitters, relay modules, or annunciator panels at a maximum distance of 2,000 feet. The power supply shall be of either 24 Vac or 24 Vdc

2. The controller will manage four internal DPDT relays at fully programmable alarm levels (and within programmable time delays) and be capable of activating multiple relay modules of eight relays each. The relay rating will be no lower than 5 A, 30 Vdc or 250 Vac (resistive load)

3. The controller to include a self-test function that allows for the activation/deactivation of all the programmed outputs by simulating a continuous 5% increase/decrease value until the maximum/minimum value is reached.

4. The controller to include a real-time clock that enables operation of the outputs for a specific timeframe.

5. The controller must also include an energy saving feature that allows for output operation on alarms set at the max, min or average value of a specific group of transmitters. This feature must also allow for the activation of outputs upon a certain number of a specific group (¾, ½, ⅓ and ¼) of transmitters reaching their alarm levels. A total of 128 groups can be assigned.

6. The controller will indicate the exact concentration of gas, the gas detected, and the location of the sensor by sweeping through the network and displaying the detected levels at each point on a graphic LCD display.

7. Provide required 120V to 24 V by gas detection manufacturer for each controller.

H. Toxic and Combustible Gas Detector- Carbon Monoxide and Nitrogen DioxidE Sensor

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal: a) Honewell Model E^3Point b) Toxalert c) Micaro

2. Review list below if AMCA-certified fans are required; not all manufacturers are AMCA members.

3. Power Requirement: 24 Vac nominal or 24Vdc, 60 Hz, 0.4A

4. Relay Output: 1 DPDT relay, 5A @ 250 Vac; 5A @ 30 Vdc

5. Communications: RS485 Modbus

6. Operating Temperature: -40° to 122°F

7. Display: 8 Character, 2 line backlit LCD

8. Visual Indicator: Green LED: Power; Amber LED 1: Alarm/Fault; Amber LED 2: Alarm/Fault

9. Audible Alarm: 85 dBA at 10ft

10. Accuracy: +/- 3% of full scale

11. Gases Detected: Carbon Monoxide (CO), Nitrogen Dioxide (NO2)

12. Transmitter will be capable of operating within relative humidity ranges of 5-95% and temperature ranges of -4° F to 104° F (-20° C to 40° C)

13. Enclosure: Polycarbonate

14. Transmitter to be powered by the control panel power supply rated at 24 Vac or 24 Vdc. Fully addressable gas transmitter must be capable of communicating digitally with controller through an RS-485 communication port. Gas transmitters must be installed in a true daisy chain with an end of the line resistor on the last transmitter. The gas transmitter will incorporate an electrochemical cell for toxic gas monitoring and catalytic bead sensor for combustible gases. Unit sensing cell must compensate for variations in relative humidity and temperature to maintain high levels of accuracy

15. When placed in a network configuration the transmitter to be capable of transmitting gas concentrations through the controller. For local activation of fans or louvers (or other equipment) an on-board DPDT relay 5 A, 30 Vdc or 250 Vac (resistive load) to be activated at

programmable set points (and programmable time delays) through the control panel. An LCD display to provide gas concentration readings.

16. The transmitter should have a plug-in capability for a gas cartridge with a smart sensor capable of self-testing
17. For local activation of audible alarms, the transmitter shall have an on-board device able to generate an audible output of 85 dBA @ 10 ft (3 m).
18. Provide splash guard enclosure (Honeywell ECLAB or approved equal) within wash down areas.
19. Provide detector guards (Honeywell E3PT-Guard or approved equal)
20. Grid to be made of a 9-gauge steel wire. The guard must be designed to allow calibration without removing the guards
21. Strobe & Horn combo (Model P2W-P) unit will be capable of operating within relative humidity ranges of 0-100% and temperature ranges of -30° F to 150° F (-35° C to 66° C). Rating of horn will be no less than 90dB at 10 feet. Intensity of light will be no less than 40W and will flash at a frequency of 1 per second

2.14 INSTRUMENTATION AND CONTROLS

A. Scope of Work

1. The Controls Contractor shall provide all labor, materials, wiring, and control devices required to ensure full functional control and integration of the following HVAC equipment:
   a. Packaged Rooftop Air Handling Units (RTUs)
   b. Gas-Fired Make-Up Air Units (MAUs)
   c. Low-Intensity Infrared (IR) Tube Heaters
   d. Maintenance Bay Ventilation System
2. Work shall include, but not be limited to:
   a. All thermostats, sensors, relays, actuators, contactors, and interface modules required for proper operation.
   b. Low-voltage control wiring between devices and HVAC equipment, including conduit, supports, junction boxes, and terminations.
   c. Interlock wiring between exhaust and make-up air systems to ensure ventilation operation when infrared or MAU heating is active.
   d. Control of maintenance exhaust and intake fans based on occupancy schedule or CO/NO_2 demand ventilation sensors if applicable.

e. Integration with Building Management System (BMS) if provided; otherwise, standalone control using thermostats, fan switches, or programmable controllers.

f. Functional testing and coordination with the Electrical Contractor for any line-voltage starters or disconnects required for fan control.

g. Control panels, relays, transformers, interlock devices, and required control power supplies.

h. Interlock wiring between equipment (e.g., fan start signal to heater enable, combustion air interlock, etc.)

i. Startup coordination and functional testing of control sequences with HVAC equipment and electrical trades.

B. Control Devices and Materials

1. Thermostats: Digital, programmable, suitable for gas heating and/or fan control.

2. Relays and Contactors: UL-listed, sized for application.

3. Sensors:

a. Temperature sensors for RTU/MAU supply, return, and space.

b. Carbon monoxide (CO) and nitrogen dioxide (NO_2) sensors for maintenance ventilation (if specified).

c. Actuators: Spring-return type for motorized dampers or louver control.

d. Control Panel Enclosures: NEMA-rated where required, labeled with device function.

e. Conduit and Boxes: EMT or flexible conduit; outdoor enclosures shall be weatherproof.

4. Control Wiring:

a. All wiring shall be stranded copper.

b. 18 AWG minimum for signal/control circuits; 14 AWG for interlocks.

c. Plenum-rated where routed in return-air spaces.

d. Color-coded and labeled at all terminations.

5. Acceptable Manufacturers:

a. Honeywell, Johnson Controls, Siemens, Belimo, Functional Devices Inc. (RIB Relays), or approved equal.

PART 3 - EXECUTION

3.0 GENERAL

C. Install all items specified under PART 2 - PRODUCTS, according to the applicable manufacturer's recommendations and shop drawings, the details shown on the drawings and as specified under this Section. Provide all required hangers and supports.

D. All welding done under this Section shall be performed by experienced welders in a neat and workmanlike manner. All welding done on piping, pressure vessels and structural steel under this Section shall be performed only by persons who are currently qualified in accordance with ANSI Code B31.1 for Pressure Piping and certified by the American Welding Society, ASME or an approved independent testing laboratory; and each such welder shall present his certificate attesting his qualifications to the Engineer's representative whenever requested to do so on the job.

E. All pipe welding shall be oxyacetylene or electric arc. High test welding rods suitable for the material to be welded shall be used throughout. All special fittings shall be carefully laid out and joints shall be accurately matched intersections. Care shall be exercised to prevent the occurrence of protruded weld metal into the pipe. All welds shall be of sound metal free from laps, cold shots, gas pockets, oxide inclusions and similar defects.

F. All necessary precautions shall be taken to prevent fire or damage occurring as the result of welding operations.

3.1 SPECIAL RESPONSIBILITIES

A. Perform work such that progress of entire project including work of other Sections shall not be interfered with or delayed.
B. Provide information as requested on items furnished under this Section which shall be installed under other Sections.
C. Obtain detailed installation information from manufacturers of equipment provided under this Section.
D. Obtain final roughing dimensions or other information as needed for complete installation of items furnished under other Sections or by Owner.
E. Keep fully informed as to shape, size and position of openings required for material or equipment to be provided under this and other Sections. Give full information so that openings required by work of this Section may be coordinated with other work and other openings and may be provided for in advance. In case of failure to provide sufficient information in proper time, provide cutting and patching or have same done, at own expense and to full satisfaction of Architect.
F. Provide information as requested as to sizes, number and locations of concrete housekeeping pads necessary for floor-mounted vibrating and rotating equipment provided under this Section.
G. Maintenance of equipment and systems: Maintain equipment and systems until Final Acceptance. Ensure adequate protection of equipment and material during delivery, storage, installation and shutdown and during delays pending final test of systems and equipment because of seasonal

H. Remove and dispose of dirt and debris, and keep premises clean. During progress of work, remove equipment and unused material. Put building and premises in neat and clean condition, and do cleaning and washing required to provide acceptable appearance and operation of equipment, to satisfaction of Architect.

3.2 MISCELLANEOUS

A. Unload materials and equipment delivered to site. Pay costs for rigging, hoisting, lowering and moving electrical equipment on and around site, in building or on roof.

3.3 COORDINATION

A. Assist in coordinating space conditions to accommodate the work of each trade where work will be installed near or will interfere with work of other trades. If installation without coordination causes interference with work of other trades, Contractor shall correct conditions without extra charge.
B. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.

3.4 BALANCING, ADJUSTING, OPERATING, AND INSTRUCTIONS

A. Engage a balancing company to adjust, balance, and operate the heating, ventilating and air-conditioning system and thoroughly instruct the Owner's personnel in all phases of care and operation of the systems. The Balancing Company shall be certified by Associated Air Balance Council or by the National Environmental Balancing Bureau.

B. Before the air systems are tested and balanced, ducts and equipment shall be thoroughly cleaned by the contractor so that no dirt, dust, or other foreign matter will be deposited in or carried through the systems. For this purpose, cheesecloth shall be placed over each opening for entraining such particles during the cleaning operation.

C. The Balancing Company will not perform water systems balancing until after the systems have been cleaned and treated by the Contractor.

D. Rooftop units shall not be operated without filters in place. All filters shall be replaced by the Contractor after rooftop units have been cleaned and ready for system balancing.

E. The Contractor as a part of this contract shall provide all materials, labor, and service of all subcontractors for fulfillment of air and water balancing of all systems. The Balancing Company shall inform Contractor of all requirements ahead of time.

F. All equipment shall be operated and adjusted and all air and water systems shall be adjusted and balanced, readings taken and recorded on an approved form submitted to the Engineer for approval, readjusted and balanced again in accordance with the Engineer's review comments and resubmitted.

3.5 Air Systems

A. After completion of balancing and adjusting, settings of dampers, shall be permanently marked by the Balancing Company so that they can be restored if disturbed at any time.

B. Adjustment of the temperature controls shall be coordinated by the person in charge of the balancing and adjusting and shall be performed coincidental therewith. In conjunction with the Automatic Temperature Control System, simulate a complete cycle of operation for each system.

3.6 TESTING

A. Test all electrical controls in accordance with respective installation manuals

3.7 SHEET METAL WORK

A. All of the sheet metal work shall be done by contractors regularly engaged in this type of work.

B. Fabrication, installation, sealing, protecting and testing of all ductwork and duct liner shall comply with the most recent publications from the Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) including but not limited to the following:

a) SMACNA HVAC Duct Construction Standards – Metal and Flexible

C. Neatly erect all sheet metal work as shown on plans or as may be required to carry out the intent of these plans and specifications.

D. All ducts are to be rigid and are to be strongly and carefully supported with suitable braces or angles to keep them true to shape and to prevent buckling.

E. All joints are to be made tight and all interior surfaces are to be made smooth.

F. All metal work in dead or furred down spaces is to be erected in time to occasion no delay in the work of other trades on the building.

G. Supply collars to diffusers shall be installed inside the neck of the diffusers. Dampers on all registers and diffusers shall be installed in the open position.

H. Joints in all ductwork throughout shall be sealed per Seal Class as specified in Ductwork in Section 2 of this specification. All ductwork shall be taped and sealed.

I. During the progress of the work and after the completion of the same, this Subcontractor shall remove from the premises all dirt, debris, rubbish, waste materials, etc., cause by him in the performance of this work, together with all his tools and appliances.

3.8 EQUIPMENT INSTALLATION

A. Install equipment so as to properly distribute equipment loads on building structural members provided for equipment support under other Sections. Roof-mounted equipment shall be installed and supported on structural steel provided under other Sections.

B. Provide suspended platforms, strap hangers, brackets, shelves, stands or legs as necessary for floor, wall or ceiling mounting of equipment as required.

C. Provide steel supports and hardware for proper installation of hangers, anchors, guides, etc.

D. Provide cuts, weights, and other pertinent data required for proper coordination of equipment support provisions and installation.

E. Structural steel and hardware shall conform to Standard Specifications of ASTM; use of steel and hardware shall conform to requirements of Section Five of Code of Practice of American Institute of Steel Construction.

F. Verify site conditions and dimensions of equipment to ensure access for proper installation of equipment without disassembly which will void warranty. Report in writing to Architect, prior to purchase or shipment of equipment involved, on conditions that may prevent proper installation.

G. Equipment shall be installed complete with all required hangers and supports in accordance with the manufacturer's recommendations.

H. Furnish and install all steel structural support members for proper hanging and support of equipment. Provide vibration isolation on all hangers.

3.9 INSULATION

A. All of the insulation work shall be done by contractors regularly engaged in this type of work in a neat and workmanlike manner. All insulation shall be completely sealed with no glass fibers exposed to the air.

B. The entire hot water piping system, all refrigerant and condensate piping systems, and applicable ductwork systems, including piping, valve bodies, fittings, specialties, etc., shall be carefully insulated throughout for thermal control and to prevent condensation. All insulated equipment which requires servicing shall be insulated with removable sections.

1. All piping insulation in mechanical room shall be enclosed in a PVC Jacket.

3.10 FLUE VENT

A. Install the stainless steel Category III flue vent system in accordance with the manufacturer’s installation instructions, UL 1738 requirements, and applicable local and national codes. Ensure all joints are sealed with manufacturer-supplied gaskets and locking bands to maintain pressure integrity. Maintain proper clearances to combustibles and support horizontal runs at intervals not exceeding 6 feet and at changes in direction. Provide a condensate drain with cleanout at the system low point. Terminate the vent system per code with an approved termination fitting, and confirm that the system is free of leaks, blockages, or mechanical stress. Clean all surfaces, remove labels, and ensure the flue system is ready for operation.

3.11 VEHICLE EXHAUST SYSTEM

A. Install the vehicle exhaust system in accordance with the manufacturer's installation instructions, local codes, and SMACNA guidelines. Mount hose reels securely to overhead structure with all weight-bearing verified by structural engineer. Connect flexible hoses to duct main using approved couplings. Provide secure and gas-tight nozzle connection to vehicle tailpipes. Mount exhaust fan and terminate duct per code above roof with required clearances. Provide tailpipe wrench adjacent to hose drop for ease of nozzle fitting.

3.12 VIBRATION ABSORPTION

A. All equipment and piping shall operate without objectionable or unusual noise or vibration, as judged by the Engineer.

B. Motor driven equipment shall have the motor, equipment and drive mounted on a common base. Hollow bed plates shall be grouted with a rich cement mortar.

C. Submit shop drawing data for approval by the Engineer showing the make, type, and size of isolation mountings, flexible pipe connectors, and other facilities to be provided, including any concrete inertia blocks that may be required. The data shall clearly indicate that the isolating arrangements can and will limit the transmission of vibration as specified.

3.13 TRAINING

A. Conduct a training course for the maintenance and operating staff. The training shall include all of the items contained in the operating and maintenance instructions as well as demonstrations of routine maintenance operations. The owner's Representative shall be given at least two weeks advance notice of such training.

3.14 INTERLOCKING AND CONTROL WIRING

A. Provide all interlock and control wiring. All wiring shall be installed neatly and professionally, in accordance with Specification Division 26 and all national, state and local electrical codes.

B. Provide wiring as required by functions as specified and as recommended by equipment manufacturers, to serve specified control functions. Provide shielded low capacitance wire for all communications trunks.

C. Control wiring shall not be installed in power circuit raceways. Magnetic starters and disconnect switches shall not be used as junction boxes. Provide auxiliary junction boxes as required. Coordinate location and arrangement of all control equipment with the owner's representative prior to rough-in.

D. Provide auxiliary pilot duty relays on motor starters as required for control function.

E. Provide power for control components from nearest BAS electrical power junction box. Refer to Division 26 for the BAS electrical power junction box locations. BAS junction boxes will include a 20 amp 120 volt circuit connected to emergency power. Provide wiring from these junction boxes, including line voltage (120 volt) wiring and low voltage (24 volt) wiring, to equipment and accessories, including but not limited to controllers, sensors, control dampers, & control valves. Transformers, wiring, conduit, junction boxes, identification, and other devices and accessories not described herein shall be in accordance to the applicable requirements of Division 26.

F. F. All control wiring in the mechanical, electrical, telephone and boiler rooms to be installed in raceways. All other wiring to be installed neatly and inconspicuously per local code requirements. If local code allows, control wiring above accessible ceiling spaces may be run with plenum rated cable (without conduit).

3.15 OPERATING AND MAINTENANCE INSTRUCTIONS

A. All operating equipment installed under this section shall be placed in operation and shall function continuously in an operating test for a period of one week without shutdown due to mechanical failure or necessity of adjustment. Prior to scheduling the Project Final Inspection and after completion of all installation and running adjustments, the HVAC Subcontractor shall perform all work required to place the equipment in complete operating condition to meet all requirements under this Specification.

B. During this running test prior, the HVAC Subcontractor shall deliver to the designated representative of the Owner, through the Architect, six complete sets of operating, service and replacement data for all equipment, which will require operating maintenance or replacement and one copy of this literature shall be available during the instruction of the operating personnel while the other is checked for completeness by the Architect.

END OF SECTION 230001

SECTION 260001

ELECTRICAL

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. PART A and DIVISION 1 of PART B are hereby made a part of this SECTION.

B. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the work of this trade.

C. Coordinate work with that of all trades affecting or affected by work of this Section. Cooperate with such trades to assure a steady progress of all work under Contract.

D. When referred to, standard specifications of technical societies, manufacturer's associations, and federal agencies shall include all amendments current as of the date of issue of these Specifications.

1.02 SCOPE OF WORK

A. The scope of the work under this Section, without limiting the generality thereof, includes all materials, labor, equipment, services and transportation, unless otherwise specified, necessary to complete all systems of electrical wiring and equipment required by the Drawings and/or specified herein. It is the intent of this Section of these Specifications and accompanying Electrical Drawings to cause these Systems to be furnished complete in every respect. The Electrical Subcontractor shall furnish all wiring, equipment, staging, access panels, and labor needed and usually furnished in connection with such work, whether specifically mentioned of not.

B. The structure and its appurtenances, clearance, and the related services such as Plumbing, Heating, Ventilating, Air Conditioning and Electrical provisions have been planned to be legal, adequate and suitable for the installation of the equipment specified under this Section. The Owner will not assume any increase in cost caused by differing requirements peculiar make or type of equipment, and any such incremental cost must be included in this Section.

C. The fire stopping of all electrical penetrations through fire resistance rated wall, partitions, floors and ceilings shall be a part of the Electrical Subcontract. The electrical contractor shall provide all required fire/smoke stopping for all electrical penetrations through all fire rated partitions and all corridor walls.

D. This Section 260001 Subcontractor shall furnish, install and maintain in a safe adequate condition all staging and scaffolding that is necessary for the proper executing of the work of this section.

E. This Section 260001 Subcontractor shall perform all cutting, coring and required for the work of this section.

1.03 RELATED WORK UNDER OTHER SECTIONS

A. Section 01 91 13 – General Commissioning

B. Painting of electrical conduits, surface metal raceways, pull boxes, hangers, panelboard doors and trim, and all other electrical equipment to match the surrounding finish as directed by the Architect, shall be done by the Section 090007 - Painting.

B. All electric motors shall be furnished and set in place by the trade requiring same and shall be wired by the Electrical Subcontractor.

C. All control devices, including thermostats, pneumatic-electric switches, electric-pneumatic switches, aquastats, fire detection thermostats, flow switches, freeze protection controls and alternators required for the automatic temperature control system shall be furnished and installed under Section 250001 – Building Automation System Section of these Specifications, unless otherwise indicated on the Electrical Drawings.

D. All automatic temperature control wiring, including wiring for all control devices shall be furnished and installed under Section 250001 – Building Automation System Section of these Specifications, unless otherwise indicated on the Electrical Drawings.

E. All electrical interlock wiring and remote control wiring required for the Heating, Ventilating, Air Conditioning and Plumbing Systems shall be furnished and installed under the Electrical Section to the extent shown on the Electrical Drawings. All interlock and control wiring not specifically shown on the Electrical Drawings but required for correct operation of the Heating, Ventilating, Air Conditioning and Plumbing Systems shall be included as work under the Heating, Air Conditioning and Plumbing Sections of these Specifications.

F. All excavating, back-filling, wood form work, reinforcing rods, and concrete work required for the installation of all electric underground manholes, ductlines and conduits shall be done under Section 312000 - Earthwork and Section 033000 – Cast-in-place Concrete. Manholes and ductlines shall be constructed in accordance with the details shown on the Electrical Drawings.

G. Refer to each Section of these Specifications for equipment furnished by Heating, Ventilating, Plumbing and equipment Subcontractor requiring connections and installation under this Subcontract. All equipment delivered to this Subcontractor for installation shall be clearly marked for location by the Supplying Subcontractor. The Supplying Subcontractor shall be responsible for all tests after the electrical connections are completed.

H. All flow alarm switches and tamper switches required for the sprinkler system shall be furnished and installed under Section 210001 - Fire Protection of these Specifications and wired under the Electrical Section.

I. The flashing of all electrical conduits passing through roofs shall be done under Section 070002 - Roofing and Flashing of these Specifications.

J. Not Used

K. All excavating, back-filling and concrete work for the roadway, parking and walkway lighting shall be provided under Section 312000 - Earthwork and Section 033000 - Cast-In-Place Concrete.

L. The Construction Manager shall pay the cost of the electrical energy consumed by all trades during the construction period and this contractor shall provide temporary lighting and power. Refer to Section 015000 - Temporary Facilities and Controls.

M. The applicable contractor shall install all access panels furnished by the Electrical Subcontractor. Electrical contractor shall coordinate all equipment that needs to be installed in ceilings or walls with the applicable contractor.

O. Not Used

P. The Electrical Contractor shall coordinate the installation of any electrical equipment associated with Door Hardware with the Door Hardware Contractor.

1.04 SHOP DRAWINGS

A. Prepare and submit complete shop drawings in accordance with requirements of Section 013300 - Submittals and in the manner described herein.

B. Shop drawings and catalog cuts shall indicate Specification Section and paragraph requiring equipment submitted.

C. Shop Drawings shall include all necessary wiring diagrams of all equipment. Shop drawings shall be required of all motor starters, disconnect switches, receptacles, lighting switches, main switchboard, emergency generator, transfer switch, lighting fixtures, lighting and power panelboards, relays, conduit, wire, fire alarm system, fire seals, sound system, floor boxes, dimmers, lighting track, underfloor duct, manholes, ductlines, surface metal raceways, scoreboards, shot timers, intrusion alarm system and auditorium dimming system.

D. Shop drawings of heavy equipment shall specify requirements, loads imposed upon the building structure, and all other information necessary to, and affecting the work of others, and the building structure.

E. Provide complete manufacturer's operating equipment manuals, diagrams and other

data to such persons as directed by the Owner for the operation and maintenance of this equipment.

F. Three (3) additional copies of all shop drawings, fixture cuts, brochures, etc., shall be furnished to the Architect/Engineer for approval and later incorporated into the operating and
maintenance manuals.

Not Used LEED Submittals:

1.05 SAMPLES

A. Submit samples of all materials as requested by the Architect.

B. Samples shall be prepared and submitted in accordance with requirements of Section 01300 - Submittals with all postage and transportation costs paid by the Contractor submitting same.

C. Submit the following samples as requested to the Architect for approval:

1. Lighting Fixtures
2. Conduit, Tubing and Flexible Conduit
3. Wire and Cable
4. Wiring Devices and Plates
5. Motor Disconnect Devices
6. Motor Starters
7. Mechanical Suspension Channel
8. Fire Alarm Station
9. Fire Alarm Signal
10. Fire Alarm Smoke Detector
11. Fire Alarm Heat Detector
12. Relays
13. Surface Metal Raceways
14. Faceplate and Back Box
15. Floor Boxes

1.06 PERMITS, LAWS AND ORDINANCES AND CODES

A. The work shall be executed in full accordance with the current rulings of the latest edition of the Electrical Code and all state and local rulings. Where codes conflict, the more stringent shall apply. Any changes necessary to the Drawings and Specifications, as submitted for bid, required to make conformity to any of the above state authorities shall be called to the attention of the Architect by this Subcontractor at the time of his Bid, otherwise he shall be held financially responsible for all work necessary for an approved installation. If this Subcontractor performs any such work knowing it to be contrary to any such laws, rules or regulations, he shall assume all costs arising therefrom to make conformity to such above rulings.

B. This Subcontractor shall obtain the necessary permits for construction and approval

of the plans by the necessary authorities and shall obtain all other permits, licenses or certificates of approval, arrange for all inspections and pay all fees and charges connected therewith. This Subcontractor shall, at the completion of the job, furnish the Architect with a certificate of inspection of the work from the authorities having jurisdiction.

C. No work shall be covered before examination and approval by the Architect and by all inspectors and authorities having jurisdiction. Replace any imperfect or condemned work with work conforming to requirements and satisfactory to the Architect, without extra cost to the Owner. If work is covered before due inspection and approval, this Subcontractor shall pay all costs of uncovering and reinstalling such work.

D. In addition to the Electrical Code and the local inspection authorities, the electrical work shall be executed in full accordance with the Occupational Safety and Health Administration's latest requirements for "Safety and Health Regulations for Construction".

1.07 RECORD DRAWINGS

A. This Subcontractor shall furnish and keep on the job at all times, one (1) complete and separate set of blackline prints of the electrical work on which shall be clearly, neatly and accurately noted, promptly as the work progresses, all architectural and electrical changes, revisions and additions to the Project. The Electrical Subcontractor shall incorporate all electrical and architectural revisions issued by the Architect. The Electrical Subcontractor shall document his work on these drawings during construction. Wherever work is installed otherwise than as shown on the Contract Drawings, such changes shall be noted.

B. Indicate daily progress on these prints by coloring in various conduits, fixtures, apparatus and associated appurtenances as they are erected.

C. No approval of requisition for work installed will be given unless supported by record prints as required above.

D. At the conclusion of work, prepare Record Drawings in accordance with the requirements Section 017700 - Project Closeout and Section 017839 – Project Record Documentation. The Electrical Subcontractor shall submit to the Architect a complete set of Electrical Record Drawing using CAD. Submit one set of drawings and a CD-ROM with a complete set of drawings files. Drawings files shall be in the DWG format and shall be Autocad 2024 compatible.

1.08 OPERATING INSTRUCTION AND MAINTENANCE MANUALS

A. This Subcontractor shall instruct to the Owner's satisfaction such persons as the Owner designates, in the proper operation and maintenance of the systems and their parts. Submit to the Architect, a letter naming the person or persons so instructed and the dates of such instruction.

B. This Subcontractor shall have video tutorials for all instructions given to the Owner on the proper operation and maintenance of the electrical systems installed under the electrical subcontract. Provide up to twelve (12) hours of video instructions and three (3) copies of the video instructions shall be given to the Architect for transmittal to the Owner. All video instructions shall be done in accordance with the requirements of Section 017700, Project Closeout and Section 017823 – Operation and Maintenance Data and Section 017900 Demonstration and Training.

C. Furnish operating and maintenance manuals in accordance with Section 01700 - Project Closeout and forward same to the Architect for transmittal to the Owner. These manuals shall be bound.

D. The operating instructions shall be specific for each system and shall include copies of
posted specific instructions

E. For maintenance purposes, provide shop drawings, parts lists, specifications and manufacturer's bulletins for each piece of equipment.

F. Provide name, address, and telephone number of the manufacturer's representative and service company for each piece of equipment so that service or spare parts can be readily obtained.

1.09 GUARANTEE

A. The manufacturer shall provide their standard guarantee for work under this Section; however, such guarantees shall be in addition to and not in lieu of all liabilities which the manufacturer and contractor may have by law or by other provisions of the Contract Documents.

B. All materials, items of equipment and workmanship furnished under this Section shall carry the standard warranty against all defects in materials and workmanship for a period of not less than one (1) year. Any fault due to defective or improper material, equipment, workmanship or design which may develop within that period shall be made good, forthwith, by and at the expense of the Electrical Subcontractor, including all other damage done to areas, materials and other systems resulting from this failure.

C. The Electrical Subcontractor shall guarantee that all elements of the systems are of sufficient as set forth or as indicated.

D. Upon receipt of notice from the Owner of failure of any part of the systems or equipment during the guarantee period, the affected part or parts shall be replaced by the Electrical Subcontractor.

E. Furnish before the final payment is made, a written guarantee covering the above requirements.

F. A lamp shall be furnished and installed in each lighting fixture as soon as fixtures are properly hung. Replace all lamps that fail within ninety (90) days after final acceptance at no additional cost. If the Electrical Subcontractor fails to replace such lamps during the above named guarantee period after a second request, the Owner may replace such lamps and back charge the Electrical Subcontractor.

1.10 EXAMINATION OF SITE AND CONTRACT DRAWINGS

A. Before submitting prices or beginning work, thoroughly make an examination of the site
and Contract Documents.

B. Bidders are advised to visit the site and inform themselves as to the conditions under which this work will be performed. Failure to do so will in no way relieve the successful bidder from the responsibility of furnishing any material or performing any work in accordance with the true intent and meaning of the Drawings and Specifications.

C. No claim for extra compensation will be recognized if difficulties are encountered which an examination of site conditions and Contract Documents prior to executing the Contract would have revealed.

D. The Electrical Subcontractor should inspect the location and length of conduit and duct runs, and the location of equipment installation mentioned in these Specifications.

E. The Electrical Subcontractor shall be responsible for ordering and furnishing the correct length of material required. The lengths shown on the Drawings are approximate only and are not warranted to be accurate nor have voltage drop calculated for actual routing in field.

1.11 WORKMANSHIP

A. The entire work provided in this Specification shall be constructed and finished in every respect in a workmanlike and substantial manner. It is not intended that the Drawings shall show every pipe, fitting and appliance, but the Electrical Subcontractor shall furnish and install all such parts as may be necessary to complete the systems in accordance with the best trades practice and to the satisfaction of the Architect.

B. This Subcontractor shall keep other Subcontractors fully informed as to shape, size and
position of all openings required for his apparatus and shall give full information to the Construction Manager and other Subcontractors sufficiently in advance of the work so that all openings may be built in advance. Furnish and install all sleeves, support, etc., hereinafter specified or required.

C. In the case of failure on the part of this Subcontractor to give proper notice and timely information as noted above, the Electrical Subcontractor shall do his own cutting and

patching at his own expense.

D. This Subcontractor shall obtain detailed information from the manufacturers of apparatus as to the proper method of installation and connecting same. He shall also obtain all information from the Construction Manager and the other Subcontractors which may be necessary to facilitate his work and the completion of the whole project.

E. Remove daily to a central location on site, all rubbish and debris and all refuse from workmen' lunches and at completion, remove all surplus materials, temporary works and construction plant and leave all work in clean condition, acceptable to the Architect.

1.12 PROTECTION

A. Each Subcontractor shall be responsible for his work and equipment until finally inspected, tested, and accepted. Carefully store materials and equipment which are not immediately installed after delivery to site. Close open ends of work with temporary covers or plugs during construction to prevent entry of obstructing material.

B. Each Subcontractor shall protect work and material of other trades from damage that might be caused by his work or workmen and make good damage thus caused.

1.13 TESTS

A. Furnish all labor, material, instruments, supplies and services and bear all costs from the accomplishment of the tests herein specified. Correct all defects appearing under test, and repeat the tests until no defects are disclosed; leave the equipment clean and ready for use.

B. All grounds, crosses, shorts, etc., must be eliminated from the wiring. Test out all lighting fixtures, together with switches and controls, test the operation of all motors, controllers and other electrical equipment devices. Each piece of electrical equipment, including lighting fixtures, motors and controls shall be operated continuously for a period of not less than one (1) hour in the presence of the Architect or his authorized representative, before acceptance.

C. The Electrical Subcontractor shall perform all tests other than herein specified which may be required by legal authorities or by agencies to whose requirements this work is to conform.

1.14 ABBREVIATIONS

UL	Underwriters' Laboratories, Inc.
NFPA	National Fire Protection Association
IEEE	Institute of Electrical & Electronic Engineers
ASTM	American Society for Testing and Materials
NEMA	National Electrical Manufacturers Association
IES	Illuminating Engineering Society

CBM Certified Ballast Manufacturers
ANSI American National Standards Institute
ICEA Insulated Cable Engineers Association
NEC National Electrical Code
AEIC Association of Edison Illuminating Companies

A. "E.C." as used hereinafter in this SECTION shall mean the "Electrical Subcontractor," i.e., the filed bid subcontractor under this SECTION 260001.

B. "Concealed" shall be defined as areas where conduit and wiring is located in chases, walls, partitions, shafts, and above finished ceilings.

C. "Underground" shall mean conduit and wiring exterior to or within the building that is buried. All other conduit and wiring shall be considered "exposed."

D. "Exposed" shall mean conduit and wiring run on the surface of the building construction.

E. "Conduit" shall mean in addition to conduit, all fittings, hangers and other accessories relating to such conduit systems.

F. "Provide" shall mean "provided complete in place," that is, "furnished and installed."

1.15 TEMPORARY FACILITIES

A. The Electrical Subcontractor shall provide at his expense, his own field office which shall be located as directed by the Architect.

B. Any temporary buildings, trailers, or other structures required by the Electrical Subcontractor shall be provided by him and shall be located as directed by the Architect and removed at completion of the work under this Subcontract.

1.16 CLEANING

A. Upon completion of the electrical installation, remove all debris, clean, polish and leave all work in perfect operating condition.

1.17 EQUIPMENT DIRECTORIES AND NAMEPLATES

A. Furnish and install typed directories under .020" clear plastic in directory cardholder in each panelboards, showing the utility of each circuit.

B. Identify each item of equipment, including disconnect switches, motor starters, panelboards, circuit breakers on switchboard, relays, contactors and cabinets, by a permanently attached nameplate made of a black surface, white core, laminated micarta with indented letters. Nameplates shall be a minimum of 2" long by 3/4" wide and shall bear the equipment name as designated in the

schedules, specifications, or on shop drawings. All nameplates shall be fastened to each piece of equipment with screws.

1.18 ACCEPTANCE OF INSTALLATION CONDITIONS

A. This Subcontractor shall be fully responsible for the proper execution and performance of the work described herein. It shall be his responsibility to inspect all installation conditions and request the construction manager arrange for correcting any conditions which may affect his work adversely. He shall report to the Architect, prior to commencing any portion of his work, any failure of the construction manager arrange for suitable installation conditions for his portion of the work.

1.19 APPROVED EQUAL

A. Approved equal shall mean that the use of all materials shall be submitted to the Architect for approval, and that such approval shall be the sole discretion of the Owner/Architect/Engineer.

B. The term "submit for approval" or similar expressions shall mean that work shall be contingent upon the specific approval of shop drawings, etc., by the Architect/Engineerin writing.

1.20 DRAWINGS

A. The Electrical Drawings are diagrammatic only and are not intended to show ever detail of construction or arbitrary location of wiring. Each system shall be complete with minor parts not specifically noted on the Drawings, but required for a properly functioning system conforming to state and local codes. Where building construction makes it advisable or necessary to change location of wiring or fixtures without increasing the cost of the work, such changes shall be made with the consent of the Architect and at no additional cost to the Owner.

B. In case of conflict with building parts or the work of other trades, the Architect shall be notified immediately and requested to render a decision so that there will be no delay in the building construction.

1.21 GIVING INFORMATION

A. Keep fully informed as to the shape, size and position of all openings and foundations required for all apparatus furnished under this SECTION and give full information to the construction manager sufficiently in advance of the work, so that all such openings and foundations may be built in advance. Furnish all sleeves and supports herein specified, so the construction manager to arrange for installation.

B. In the case of failure to give proper information as noted above, assume the cost of having necessary changes to the work made by the construction manager.

C. Obtain detailed information from the manufacturers of apparatus which is to be provided, for the proper methods of installation. Obtain all information from the General Contractor and other Subcontractors which may be necessary to facilitate the work and the completion of the whole project.

D. Electrical Subcontractor shall inspect the site associated with this project prior to submitting his bid and shall investigate all conditions under which this work will be performed. This shall include determination of exact locations of items indicated as existing on the Drawings. Such existing locations are diagrammatic and shall not be construed as exact enough to use for equipment and labor estimating purposes. Failure to inspect existing conditions or to fully understand the work which is required shall not excuse the Electrical Subcontractor from his obligation to supply and install work in accordance with the Specifications and Drawings and under all existing site conditions. It shall be the responsibility of the Electrical Subcontractor to investigate and locate all existing underground utilities which may conflict with the installation of this electrical work. Coordinate elevations of conduits required to be installed under this Contract to avoid interference with any existing underground utilities.

1.22 COORDINATION DRAWINGS

A. Before materials are purchased or work is begun the Subcontractor shall prepare Coordination Drawings showing the size and location of his equipment and lines in the manner described under Section 013300 – Submittals. Base all required measurements, both horizontal and vertical, on reference points established by the General Contractor and be responsible for the correct laying out of the electrical work. In the event of a discrepancy between actual measurements and those indicated, notify the General Contractor in writing, and do not proceed with the work required until written instructions have been issued by the General Contractor.

B. HVAC, Plumbing, Fire Protection, and Electrical Drawings are diagrammatic. They indicate general arrangements of mechanical and electrical systems and other work. They do not show all offsets required for coordination nor do they show the exact routings and locations needed to coordinate with structure and other trades and to meet Architectural requirements.

C. Work shall be performed in cooperation with other trades on the project and so scheduled as to allow speedy and efficient completion of the work.

D. Furnish to other trades advance information on locations and sizes of all frames, boxes, sleeves and openings needed for their work, and also furnish information and shop drawings necessary to permit trades affected by the work to install same properly and without delay.

E. In all spaces, prior to installation of visible material and equipment, including access panels, review Architectural Drawings for exact locations and where not definitely indicated, request information from Designer. Where the electrical work shall interfere with the work of other trades, assist in working out the space conditions to make satisfactory adjustments before installation. Without extra cost to Owner, make reasonable modifications to the work as required by normal structural interferences. Pay the General Contractor for additional openings, or relocating and/or enlarging existing openings through concrete floors, walls, beams and roof required for any work which was not properly coordinated. Maintain maximum headroom at all locations. All piping, duct, conduit, and associated components to be as tight to underside of structure as possible.

F. If any electrical work has been installed before coordination with other trades so as to cause interference with the work of such trades, all necessary adjustments and corrections shall be made by the electrical trades involved without extra cost to Owner.

G. Where conflicts or potential conflicts exist and engineering guidance is desired, submit sketch of proposed resolution to Designer for review and approval.

H. Protect all materials and work of other trades from damage which may be caused by the electrical work, and repair all damages without extra cost to Owner.

I. HVAC and Building Automation Subcontractors shall furnish and install various electrical items relating to the heating and ventilating equipment and control apparatus. The Electrical Subcontractor shall be required to connect power wiring to this equipment as indicated on the electrical drawings unless noted otherwise.

J. The HVAC, BAS, Security and Electrical Subcontractors shall coordinate their respective portions of the work, as well as the electrical characteristics of the heating and ventilating equipment.

K. All power wiring and local disconnect switches will be provided by the Electrical Subcontractor for the line voltage power. All control and interlocking wiring shall be the responsibility of the BAS Subcontractor.

L. 120V and above power wiring sources extended and connected to heating and ventilating control panels, transformers and switches shall be the responsibility of the Electrical Subcontractor as indicated on the electrical drawings. All other 120V wiring not shown on the electrical drawings but required by the BMS contractor shall be furnished and installed by the BMS Contractor. All low voltage thermostat, zone valve and any switch wiring shall be the responsibility of the BAS Subcontractor.

M. Temperature control and equipment wiring shall be installed by BAS Subcontractor.

N. The Electrical Subcontractor will furnish and install all magnetic starters except those furnished as an integral part of packaged equipment.

1.24 ALTERNATES

A. Not Used

1.25 CONSTRUCTION SCHEDULE

A. All work under this Contract shall be arrange and carried out in a continuous manner permitting completion of the work in accordance with the completion dates outlined in the Contract Documents.

B. It is essential to the successful performance of the Contract that the Electrical Subcontractor initiate orders for all "lead time" items immediately upon execution of the Contract agreement. Submit equipment and material list and shop drawings for the "lead time" items as soon as possible after the Contract award and notify the Architect at that time of any possible foreseeable delivery delays. Place orders immediately upon receipt of approvals and follow through on all items to avoid construction delays and to assure compliance with established scheduled Project completion time.

C. It shall be the responsibility of the Electrical Subcontractor to properly staff the Project with competent personnel to insure proper supervision and control.

D. It is imperative that the Project be staffed at all times by the Electrical Subcontractor with the required number of personnel to adhere to the construction schedules and completion dates.

E. It shall be the responsibility of the Electrical Subcontractor to coordinate with the construction manager the phasing of this project. The Electrical Subcontractor shall install the electrical installation within the requirements of the phasing requirements of the construction manager and the phasing information shown on the Construction Documents and Technical Specifications.

PART 2 - PRODUCTS

2.01 GENERAL

A. Materials specified for the work on all systems in this building shall be new and shall comply with the National Electrical Manufacturers Association's specifications (NEMA), the Electrical Code and the American National Standards Institute (ANSI). Where materials are not specified, these materials shall be the best of their respective kinds. Submit a list of all materials to the Architect for approval within thirty (30) days after the contract is signed and before any orders are placed. Wiring materials, stock fixtures and equipment shall bear the label of the Underwriters' Laboratories, Inc. (UL), or shall be accompanied by a duly signed certificate from an approved inspection organization which states that the requirements of the Underwriters' Laboratories, Inc. (UL) for such materials and/or equipment have been complied with, but such label or certificate shall not obligate the Architect to approve said materials, fixtures and/or equipment.

B. Reduction, submit product data for all exterior lighting fixtures.

2.02 RIGID METAL CONDUIT

A. Rigid metal conduit shall be manufactured of fine, evenly-grained steel. Rigid metal conduit shall be threaded and shall be thoroughly cleaned to remove all scale and rust before applying a galvanized coating outside and a coating of clear, baked-on enamel on the interior surfaces. Rigid conduit shall be of full weight and shall meet all Electrical Codes and Underwriters' Laboratories, Inc. standards for rigid metal conduit. Each standard length shall be threaded at both ends and fitted with a coupling at one end and a thread protector at the other. All rigid metal conduit fittings shall be threaded and shall be made of full weight material and treated with the same protective coatings required for rigid conduit. Set screw-type connectors and couplings for rigid metal conduit will not be allowed. Rigid metal conduit shall be used in concrete or other wet construction unless indicated otherwise on the Drawings.

B. Thread fittings such as elbows, bends, etc., shall be made of full weight material and treated with the same protective coatings required for rigid metal conduit. Set screw-type connectors will not be allowed.

C. All conduit shall be supported with a minimum of two (2) hanger supports for each ten (10) feet of conduit and additional supports shall be provided where structural conditions require them. On flat surfaces, supports shall consist of one-hole heavy wall conduit clamps and one-hole conduit clamp backs.

D. Conduit shall be manufactured by one of the following or approved equal:

Allied Tube & Conduit Corp. LTV Steel Tubular Products

Wheatland Tube Company Triangle Conduit Company

2.03 ELECTRIC METALLIC TUBING

A. Electric metallic tubing (EMT) shall be of welded steel construction and manufactured of light-weight, cold-rolled steel. The exterior shall be protected by an electro-galvanized zinc coating. The interior shall be coated with lacquer. Fittings for electric metallic tubing shall be of the threadless type and shall be constructed and finished as described for tubing. All fittings for tubing shall be of the compression or set-screw and shall be of the steel type. Tubing shall not be installed in concrete or other wet constructions.

B. Electric metallic tubing shall be supported as specified for rigid metal conduit.

C. Electric metallic tubing shall be manufactured by one of the following or approved equal:

Allied Tube & Conduit Corp. LTV Steel Tubular Products
Wheatland Tube Company Triangle Conduit Company

2.04 FLEXIBLE METAL CONDUIT

A. Flexible metal conduit shall be constructed of continuous interlocking bands of zinc-coated steel and shall be complete with fittings approved for this type of conduit. Flexible conduit, known as Greenfield, shall be used to connect a motor to its junction box or recessed lighting fixture to its junction box. In mechanical rooms and wet locations, install UL approved liquid-tight flexible metallic conduit for final connection to motors with flexible length not-to-exceed six (6) feet.

B. Flexible metal conduit shall be manufactured by one of the following or approved equal:

American Flexible Conduit
Electric-flex Company
Alflex Corp.
Allied Tube & Conduit Corp.

2.05 PLASTIC CONDUIT

A. Plastic conduit encased in concrete shall be schedule 40, rated for 90 degrees C. Cables and plastic conduit installed underground (direct burial) shall also be schedule 40. Plastic conduit shall be composed of polyvinyl chloride, U.L. listed and shall conform to NEMA standards TC-2 and Article 347 of the National Electrical Code. The materials shall have a tensile strength of 6,000 PSI at 73.4 degrees F, flexural strength of 12,500 PSI, tensile modules 470,000 PSI and a compressive strength of 9,000 PSI.

B. Plastic conduit, fittings, and elbows shall be produced by the same manufacturer. All joints shall be solvent welded in accordance with the recommendations of the manufacturer.

C. Plastic conduit shall only be installed in underground locations as indicated on the Electrical Drawings. Plastic conduit shall **NOT** be installed within the Building or in any concrete floor slab. All PVC conduit within the underground ductline system shall be concrete encased. Light and power feeders may be installed in PVC conduits under the first floor slab without being concrete encased.

D. Plastic conduit and fittings shall be manufactured by one of the following or approved equal:

Carlon Products Corporation
Cantex, Inc.
Scepter Electrical Systems

2.06 METAL CLAD CABLE

A. Metal clad cable (type MC) shall be made of interlock galvanized steel protective armor, solid insulated copper conductors. All conductors shall be insulated solid copper conductors. Type MC cable shall have a solid fully rated insulated green ground conductor. Type MC cable shall be furnished in accordance with the National Electrical Code. Type MC cable shall be used for lighting, and receptacle branch circuit wiring in concealed locations. No type MC cable will be allowed for panel feeders. All fittings shall be steel, dies cast fitting are not allowed. Refer to General Note on Symbol List for details.

B. Type MC cable shall be AFC type MC metal clad cable or approved equal.

2.07 OUTLET BOXES

A. Outlet boxes on concealed conduit work shall be of galvanized steel. These boxes, in all cases, shall be designed to accommodate the equipment or apparatus to be installed either in them or attached to them. Where boxes of a standard size are not available for a particular requirement, special boxes shall be manufactured and furnished to comply with the requirements. Outlet boxes shall be furnished of a size and type to meet the requirements of each type of concrete construction. If standard boxes are not available, special boxes shall be furnished as required by each type of construction.

B. Barriers shall be provided where two (2) or more electric system have wires or connections in the same box. Boxes shall be furnished of a size and type to meet the requirements of each type of construction. Special boxes shall be furnished as required by each type of construction.

C. Where boxes are used to support fixtures on ceiling or on the walls, suitable fixture supports of the required type for the specific fixture shall be furnished in

each box. Plaster rings shall be furnished of the required depth to meet the conditions for all locations where plaster construction is specified for walls and ceilings. Where lighting fixtures are specified to be installed in concrete ceiling construction, fixture back boxes designed for this purpose shall be provided.

D. Outlet boxes for exposed work in mechanical areas shall be of cast malleable iron with cast covers designed for the specific device. Cast-iron boxes shall have cadmium finish

E. All fittings for exposed conduit work shall be malleable galvanized steel of the type and size adequate to meet the structural and architectural requirements at each locations.

F. Outlet boxes shall be manufactured by one of the following or approved equal:

Crouse-Hinds Company	L.E. Mason Company
Appleton Electric Co.	Killark Electric Mfg. Co.
All Steel Equipment, Inc.	Steel City Electric Co.

2.08 PULL AND JUNCTION BOXES

A. Pull and junction boxes shall be of the proper type, class and construction to suit the specific conditions encountered.

B. Pull and junction boxes shall be of sufficient volume and physical configuration to accommodate the number of conductors entering and leaving the box as well as any splices or connections that may be made within same.

C. Pull and junction boxes that are not specifically shown on the Drawings, but are required for the proper installation of the electrical system shall be installed by the Electrical Subcontractor so that they do not interfere with the structural or architectural features of the building.

D. Pull and junction boxes shall be constructed of code gauge galvanized sheet metal, of not less than the minimum size required by the Electrical Code or other applicable specification standards and shall be furnished with screw fastened covers. Boxes exceeding 48" in any direction shall be properly reinforced with angle iron stiffeners.

E. Pull and junction boxes of other than manufacturer's trade size shall be manufactured by one of the following or approved equal

Keystone Manufacturing Company
Lee Products Company
Commercial Sheet Steel

2.09 WIREWAY

A. Wireway shall be made of code gauge galvanized steel with formed flanges on body and cover. Finish shall be gray baked enamel and the covers shall be fastened to the body with screws. Wireways shall be furnished with the necessary fittings, including elbows, tees, end caps, couplings, flanges, and hangers.

B. Wireway shall be securely supported at intervals not exceeding five (5) feet.

C. Wireways shall be manufactured by one of the following or approved equal:

Square D Company Lee Products Company
Commercial Sheet Steel

2.10 BRANCH CIRCUIT AND FEEDER CONDUCTORS

A. All branch circuit wiring for lighting, receptacles and power branch circuits shall be manufactured of copper with a minimum size of #12 solid AWG. All wiring shall be rated at 600 volts with a type THWN/THHN insulation and conductors #10 AWG and larger shall be stranded. All HVAC and power wiring shall be installed in conduit raceways (Rigid or EMT). Receptacle and lighting branch circuit homerun wiring from the panel to each room shall be and all lighting and branch circuit wiring in the walls shall be type MC cable or installed in surface metal raceways.

B. All lighting and power feeders shall manufactured of copper and rated at 600 volts with THWN insulation.

C. All branch circuit and feeder conductors shall conform to the Electrical Code requirements as to construction and use.

D. The interior wire for the fire alarm system shall be copper, #14 AWG, type THWN twisted pair for for strobe light circuits and rated at 600 volts unless otherwise indicated on the Electrical Drawings. The addressable loop circuits shall be a shielded cable. All firing alarm wiring shall be installed in conduit raceways (EMT) (exposed) or fire alarm mc cable (concealed).

E. The interior wire for remote control, signal circuits and interlocking wiring shall be copper #16 AWG, type THHN Twisted Pair and rated at 600 volts unless otherwise indicated on the Electrical Drawings.

F. All exterior wiring shall be copper, type THWN and rated at 600 volts unless otherwise indicated on the Electrical Drawings.

G. Wiring installed in one (1) section of a continuous LED lighting fixture to supply a ballast in another section of the same continuous fixture shall be type SFF, rated at 150 degrees C. with the insulation rated at 300 volts.

H. All branch circuit and feeder conductors shall be color coded for phase identification. Phases shall be identified by the following colors throughout:

120/208 Volts	277/480 Volts
A Phase - Black	A Phase - Brown
B Phase - Red	B Phase - Orange
C Phase - Blue	C Phase - Yellow
Neutral- White	Neutral - White with Colored Stripe
Ground - Green	Ground - Green

I. Switch leg wiring shall be of the same color as the corresponding phase.

J. Phase markings shall be accomplished as follows:

1. Wires of #6 gauge and smaller shall have an outer braid of insulation of a solid continuous color for the entire length.

2. It is preferable that wires larger than #6 gauge shall have an outer braid or insulation of a solid continuous color for the entire length. If the particular manufacturer of wire ordered for this project does not provide such continuous coloring, wires shall be identified by a gummed plastic or cellophane marker tape which can be wrapped around the outer braid. Such markers shall be a type as manufactured by the W.H. Brady Company of Milwaukee, Wisconsin, or approved equal. The wires shall be so identified at any and all points of connection to equipment.

K. Branch circuit and feeder conductors shall be manufactured by one of the following or approved equal:

Rome Cable Corporation
American Insulated Wire Corp.
Hi-Tech Cable Corp
Southwire Company

2.11 SOLDERLESS LUGS AND CONNECTORS

A. All lugs terminating feeder conductors shall be of the solderless type approved by Underwriters' Laboratories for use with copper wires.

B. Branch circuit connections or joints shall have an approved type connector suitable for copper conductors.

C. Wire connectors shall consist of a phenolic compound body with a cone-shaped coil spring and threaded skirt. Outer shell shall be knurled for each grip and capable of use with wrench or pliers.

D. Lugs shall be manufactured by one of the following or approved equal:

Trego Incorporated Burndy Corporation
O.Z. Gedney Company

E. Wire connectors shall be manufactured by one of the following or approved equal:

3M Company Burndy Corporation
Ideal Industries

2.12 PANELBOARDS AND CABINETS

A. Each panelboard shall consist of automatic short-circuit and over-current protective devices assembled into a single interior unit which shall be mounted in a sheet steel enclosure, consisting of a box and front designed to be placed in or against a wall or partition. The panelboards shall be of the dead-front type and shall be in accordance with the Underwriters' Laboratories, Inc. standard for panelboards and enclosing cabinets, and so labeled.

B. The panelboard boxes shall be fabricated from galvanized sheet steel. A turned edge shall be provided around the front of the box for rigidity and attachment of the front. Wiring gutters shall be in accordance with the Electrical Code. All lighting and power panelboards shall be furnished with an equipment ground bus.

C. The panelboard front shall consist of a flat piece of sheet steel, with a door-in-door arrangement. One door shall expose the circuit breaker handles and the other door will provide access to the wiring gutters. The panelboard doors shall be attached by means of semi-concealed, 5-knuckle steel hinges. The doors shall have cylinder tumbler-type lock. On doors more than 48" high, a combination 3-point catch and lock shall be provided. The front shall be attached to the box with rotating adjustable trim clamps. A 5" x 7" circuit directory card and cardholder shall be provide on the inside of the door. Fronts shall be finished in ANSI-61 light gray enamel over a rust inhibitor, except in finished building areas and panels shall primed for painting. All panelboards shall be furnished with locks and all locks shall be keyed alike.

D. The interior shall be of the unit type mounted on a back plate, properly reinforced by flanging to provide a rigid assembly to protect against damage during handling or installation. Structure shall be so designed that units may be easily removed without disturbing adjacent sections, bus structure or insulation. A removable dead front shield shall be provided for easy access to the wiring. Panel bussing shall be arranged to maintain sequence phasing throughout, that is, adjacent poles shall be unlike polarity and rotated in sequence. All lugs shall be of the solderless type, suitable for copper conductors. See paragraph entitled "Solderless Lugs and Connectors".

E. Branch circuit protective devices shall be ABB Company or approved equal, molded case circuit breakers. The breakers shall have quick-make, quick-break toggle mechanism, inverse time-limit characteristics and shall be trip-free on

over-load or short-circuit. Automatic release is to be secured through the medium of bi-metallic, thermal type element engaging the releasing latch of the mechanism. In addition, a magnetic armature shall be provided and calibrated so as to trip the breaker instantaneously for short-circuits above the over-load range.

F. Automatic tripping shall be indicated by handle automatically assuming a position between the manual "OFF" and "ON" position. The individual breakers shall be calibrated and sealed to eliminate tampering or unauthorized changes in calibration. Breakers shall be interchangeable and capable of being operated in any position. Two and three-pole breakers shall be common trip so that an over-load on one pole will trip all poles simultaneously. All circuit breakers with frame sizes larger than 100-amperes rating shall have interchangeable trips. No "Common trip" handle bar ties will be allowed on "Q-Line" multi-pole circuit breakers to accomplish either manual or automatic tripping.

G. Where more than one (1) panel occurs at any one (1) location, a common trim shall be provided with separate panel access doors.

H. No plug-in type circuit breakers will be allowed, and no feed-through bus panels will be approved.

I. All lighting and power panelboards shall be furnished with an equipment ground bus.

J. The exact type of circuit breaker required for each lighting and power panelboard shall be determined from the panel schedules on the Electrical Drawings.

K. The NEMA interrupting ratings of molded case circuit breakers shall be as follows:

<u>120/208 Volts - Three Phase - Four Wire System</u>

100-ampere frame, ABBABB type THQB, 10,000-ampere RMS at 120/240-volts AC (for lighting and receptacle branch circuits only)

100-ampere frame, ABB Co., type THHQB, 22,000-ampere RMS at 120/240-volts AC (for lighting and receptacle branch circuits only)

100-ampere frame, ABB Co., type TXQB, 65,000-ampere RMS at 120/240-volts AC (for lighting and receptacle branch circuits only)

100-ampere frame, ABB Co., type TEB, 10,000-ampere RMS at 240-volts AC (for power branch circuits)

100-ampere frame, ABB Co., type TED, 18,000-ampere RMS at 240-volts AC.

100-ampere frame, ABB Co., type THED, 65,000-ampere RMS at 240-volts AC.

225-ampere frame, ABB Co., type TFK, 25,000-ampere RMS at 240-volts AC.

225-ampere frame, ABB Co., type THFK, 65,000-ampere RMS at 240-volts AC.

400-ampere frame, ABB Co., type TJK4, 42,000-ampere RMS at 240-volts AC.

600-ampere frame, ABB Co., type TJK6, 42,000-ampere RMS at 240-volts AC.

800-ampere frame, ABB Co., type TKM8, 42,000-ampere RMS at 240-volts AC.

277/480 Volts - Three Phase - Four Wire System

100-ampere frame, ABB Co., type TED, 14,000-amperes RMS at 277/480-volts AC.
100-ampere frame, ABB Co., type THED, 65,000-ampere RMS at 277-volts AC

225-ampere frame, ABB Co., type TFK, 22,000-amperes RMS at 480-volts AC.

225-ampere frame, ABB Co., type THFK, 25,000-amperes RMS at 480-volts AC.

400-ampere frame, ABB Co., type TJK4, 30,000-amperes RMS at 480-volts AC.

400-ampere frame, ABB Co., type THJK4, 35,000-amperes RMS at 480-volts AC.

600-ampere frame, ABB Co., type TJK6, 30,000-amperes RMS at 480-volts AC.

800-ampere frame, ABB Co., type TKM8, 30,000-amperes RMS at 480-volts AC.

800-ampere frame, ABB Co., type THKM8, 35,000-amperes RMS at 480-volts AC.

L. Type THQB, THHQB or TXQB circuit breakers or the equivalent shall not be used for any power branch circuits or in any distribution panelboards as identified by panel schedules on the Drawings.

M. All lighting and power distribution panelboards shall be ABB Company, type CCB.

N. Panelboards and cabinets shall be manufactured by one of the following or approved equal:

ABB Company
Cutler Hammer Company
Square D Company
Siemens

2.13 RECEPTACLES

A. Duplex receptacles shall be rated at 20-amperes, 3-wire, 125-volts, with "T" slots, ground slot, double binding screws and plaster ears and shall be Hubble HBL5362 or approved equal.

B. Single receptacles rated at 20-amperes, 3-wire, 125-volts shall be Hubbell #HBL5361 or approved equal.

C. Duplex ground fault interrupter (GFI) receptacles shall be rated at 20-amperes, 3-wire, 125-volts with ground slot and shall be Hubble HBL5362GF or approved equal.

D. Ground fault interrupters installed in wet locations shall be installed in FS boxes with Arrow Hart #4501FS cast aluminum covers. Receptacles mounted outside shall be weather resistant per MEC.

E. Tamper resistant duplex receptacles shall be rated at 20-amperes, 3-wire, 125-volts, with "T" slots, ground slot, double binding screws and plaster ears and shall be Hubble HBL5362 or approved equal.

E. Duplex surge suppression receptacles shall be rated at 20-amperes, 125-volts with ground slot, power-on, damage alert alarm, blue face and shall be Hubbell #HBL5362-S or approved equal.

F. Duplex isolated ground surge suppression receptacles shall be rated at 20-amperes, 125-volts with ground slot, power-on, damage alert alarm, blue face and shall be Hubbell #HBLIG5362-S or approved equal.

G. Single dryer receptacles rated at 30-amperes, 4-wire, 125/250-volts shall be Arrow Hart, Inc. #5744N or approved equal and shall match the dryer cord set.

H. Single receptacles rated at 30-amperes, 3-wire, 125-volts, shall be Arrow Hart #5716N or approved equal.

I. The color of all receptacles connected to the emergency light and power system shall be red.

J. The color of all receptacles shall be "brown" or "ivory". In general, receptacles installed in all finished areas throughout the building shall be "ivory" and receptacles installed in areas with wood paneling or in wood furniture shall be "brown". All receptacles installed in storage, boiler, mechanical and electric rooms shall be "brown". The exact color of the receptacles for each of the various areas of the building shall be determined by the Architect.

K. Receptacles shall be manufactured by one of the following or approved equal:

Arrow Hart, Inc.
Pass & Seymour
Hubbell, Inc.

2.14 SWITCHES

A. All toggle switches except those required for special application shall be of the same manufacturer.

B. Switches for use on incandescent or LED lighting circuits shall be of the AC general use type and shall be fully rated at 20-amperes at 120/277-volts.

C. AC toggle switches shall be specification grade, heavy duty, single or double pole, 3 or 4 way, or maintained momentary, or lock-type as indicated by the symbols on the Drawings.

D. Toggle switches shall be of the fully rated enclosed cap type with the entire body of molded phenolic, urea, or melamine.

E. Switch handles shall be of an "ivory" color.

F. Switches shall be classed as "silent-acting".

G. All toggle switches shall comply with Underwriters' Laboratories, Inc. standards.

H. Single-pole switches shall be Hubble HBL1221 or approved equal, rated at 20-amperes, 120/277-volts.

I. Double-pole switches shall be Hubble HBL1222 or approved equal, rated at 20-amperes, 120/277-volts.

J. Three-pole switches shall be Hubble HBL1223 or approved equal, rated at 20-amperes, 120/277-volts.

K. Four-pole switches shall be Hubble HBL1224 or approved equal, rated at 20-amperes, 120/277-volts.

L. Momentary contact switches shall be Arrow Hart #1995 or approved equal, rated at 120/277-volts.

M. All pilot lights rated at 120-volts shall be neon with red lucite jewel and shall be Arrow Hart #1720 or approved equal.

N. All pilot lights rated at 277 volts shall be neon with red lucite jewel and shall be Arrow Hart #1722 or approved equal.

O. In general, switches installed in all finished areas throughout the building shall be "ivory" and switches installed in areas with wood paneling or in wood furniture shall be "brown". All switches installed in storage, boiler, mechanical and electric rooms shall be "brown". The exact color of the switches for each of the various areas of the building shall be determined by the Architect.

P. Switches shall be manufactured by one of the following or approved equal:

Arrow Hart, Inc. Hubbell, Inc.
Pass & Seymour

2.15 DEVICE PLATES

A. A metal device plate shall be provided for each switch, receptacle, signal and special purpose outlet.

B. All device plates shall be stainless steel with a brushed finished and shall be corrosion resistant (18 percent chromium, 8 percent nickel). Device plates shall be Arrow Hart, 93,000 series or approved equal.

C. The color of all device plates for receptacles connected to the emergency light and power system shall be stainless steel with a red finish.

D. Screws for device plates shall match the plates.

A. Device Plates shall be manufactured by one of the following or approved equal:

Arrow Hart, Inc. Hubbell, Inc.
Pass & Seymour

2.16 FLOOR BOXES

A. All floor boxes shall be of the cast iron watertight, fully adjustable type with four (4) wiring compartments. Floor boxes shall be of the multiple service type with steel wiring compartment covers to allow wiring feed-thru from one compartment to another. Floor boxes shall be furnished with the necessary Duplex receptacle brackets, Duplex tel/data brackets, flush access hatch, carpet trim and wire management blocks. Each floor box shall be designed to accept two (2) Duplex surge receptacles and two (2) Duplex tel/data jacks. All tel/data jacks and associated wiring shall be furnished and installed by others.

B. Floor boxes shall be Wiremold #RFB11-C1, RFB6-C1, RFB2-C1 or approved equal with a Wiremold flush access hatch. Refer to the symbol list. Access hatch covers shall be reversible with vertical and angular adjustments to permit matching to uneven surfaces.

C. All floor boxes for receptacles only shall be of the cast iron, waterlight, fully adjustable, rectangular type and shall be Steel City Electric Company 641, 642, 643 and 644 or approved equal. The cover plates shall be furnished with sealing gaskets, flat head screws, and a brass furnish. The cover plated for all duplex device/receptacles shall be of the duplex lift lid type and the cover plates for the single devices shall be of the plug type. Each floor box shall be provided with the correct cover configuration to match the device symbol shown on the Electrical

Drawings. All cover plates shall be Steel City Electric Co. P64 series or approved equal with a brass finish.

D. Whenever floor boxes are installed in carpeted areas, the floor boxes shall be furnished with carpet flanges. All device plates installed in the floor boxes shall be of the type and capacity shown on the Electrical Drawings and as specified in the "Products" Section of the Specifications.

E. Whenever floor boxes are installed in concrete floors, the metal deck shall be cut as required to install the top of the floor box level with the concrete slab.

2.17 MOTOR DISCONNECT SWITCHES

A. Disconnect switches: Power switches for disconnecting means at all motors ½ HP and over shall be heavy duty type with quick-make, quick-break mechanisms. Disconnect switches shall have interlocking doors. Cabinets shall be bonderized and furnished in gray enamel. Where one (1) feeder supplies more than one motor, disconnecting switches shall be fusible type and shall be complete with fuses of the size required for each motor. NEMA type 3R enclosures shall be used where the disconnect switch is exposed to the weather or installed in wet locations. Disconnect switches shall be capable of being secured in the open position with a padlock.

B. A manual starting thermal-type switch with pilot light shall be provided as a disconnecting means for all motors less than ½ HP unless otherwise indicated on the Electrical Drawings. These thermal switches shall be toggle operated and shall be rated at 1 HP, size 00. Motor overload protection shall be provided by means of a bi-metallic type thermal relay in combination with interchangeable heaters. Heaters shall be installed without removing the starter from the housing or disturbing the wiring. Toggle shall be trip-free. Thermal switches shall be furnished in a NEMA type 1 enclosure in mechanical and utility areas and flush in walls with stainless steel plates in architecturally finished areas.

C. Motor disconnect switches shall be mounted in NEMA type 1 or 3R enclosures and shall be ABB Company, type TH or approved equal.

D. Motor disconnect switches shall be manufactured by one of the following or approved equal:

ABB Company
Square D Company
Siemens
Cutler Hammer

2.18 MAGNETIC STARTERS

A. All motors ½ HP thru 60 HP connected to the 480 volt system shall be solid state wye delta. These motors shall be designed to operate on 480 volts, 3-phase, 60 hertz.

B. Across-the-line starters shall be enclosed in NEMA general purpose enclosures, except NEMA type 3R enclosures shall be used where the starter is exposed to the weather and NEMA type 5 enclosures shall be used in all hazardous locations. Across-the-line starters shall NEMA size 1, 2, or 3 depending on the size of the motor. Momentary contact start-stop pushbuttons shall be located in the covers of the starters enclosure unless other type of starting switches are required. Current sensitive relays shall be provided in each line to the motor to guard against continued operation at excessive loads. These relays shall be of the bi-metallic type "inverse-time" operating characteristics. Heaters shall be provided of the correct size for the motor controlled. Two (2) sets of auxiliary contacts shall be provided with each starter in addition to those needed for normal operation or in addition to those required by the wiring diagrams. These auxiliary contacts shall be "normally open" or "normally closed" depending on the specific control circuit requirements. Red and green pilot lights shall be located in the cover of the starter enclosure to indicate position of
main contacts.

C. Two-speed magnetic starters shall consist of two mechanical and electrically interlocked contactors with two three-leg block type overload relays, one on each contactor. Relays shall provide overload protection for each speed. Provide pilot lights to indicate each of the motor speeds. Provide auxiliary contacts, starting switches and pilot lights as specified for across-the-line starters.

D. The Electrical Subcontractor shall consult with the Automatic Temperature Control Subcontractor to determine the type of control required for each magnetic starter (start-stop pushbuttons or HOA switches).

E. Furnish and install a 480/120 volt fused transformer of the required size in each magnetic starter enclosure for control power. Control power transformers are required for all starters connected to the 480 volt system.

F. Magnetic or manual starters shall be manufactured by one of the following or approved equal:

ABB Company
Square D Company
Siemens
Cutler Hammer

2.19 MECHANICAL SUSPENSION CHANNEL

A. Mechanical suspension channel shall be furnished and erected and used to support electrical equipment such as panelboards, starters, disconnect switches,

plywood backboards and the like. All channel and fittings shall be furnished with the manufacturers standard rust-proofing finish.

B. Channel shall be factory formed of 12-gauge steel and shall have outside cross section measuring 1-1/2" x 1-1/2" or approximately that size, provide that the moment of inertia and the section modulus in the horizontal axis of the channel are at least equal to that of the above-described Section. All required fasteners and fittings shall be furnished to satisfactorily complete the installation as shown on the Electrical Drawings.

C. Mechanical suspension channel shall be manufactured by one of the following or approved equal:

Unistrut Products Company
Power-Strut
Kindorf (Steel City Electric Co.)

2.20 120 OR 277-VOLT LIGHTING CONTROL RELAYS

A. 120 or 277-volt lighting control relays shall be rated at 25-amperes and shall be of the mechanically held or magnetically held type as indicated on the Electrical Drawings. In general, relays for the control of lighting fixtures shall be of the mechanically held type on the normal lighting circuits and relays for the control of small power circuits shall be of the magnetically held type. Relays shall be fully rated when enclosed in metal cabinets.

B. 120 or 277-volt lighting control relays shall be manufactured by one of the following or approved equal:

Automatic Switch Company ABB Company
Allen-Bradley Company

2.21 MAIN SECONDARY SWITCHBOARD

Not Used

2.22 Not Used EMERGENCY GENERATOR UNIT– (Existing to remain shall be used)

2.23 Not Used AUTOMATIC TRANSFER SWITCH (Existing to remain shall be used)

2.24 Not Used DRY-TYPE TRANSFORMER

2.26 THERMAL SWITCHES

A. Thermal switches shall be NEMA Type 1 toggle switch for normal duty with thermal overload relay. Switch enclosures shall be of a type approved for the location and atmosphere in which it is mounted. Thermal switches shall be installed where called for or where required by Code. Thermal switches shall be provided with pilot where called for on the drawings.

B. Thermal switches shall be as manufactured by Square D, ABB, Siemens, or equal.

2.27 ACCESS PANELS

A. Provide access panels for access to concealed junction boxes and to other concealed parts of system that require accessibility for operation and maintenance. In general, electrical work shall be laid out so access panels are not required.

B. Access panels shall be located in a workmanlike manner in closets, storage rooms, and/or other non-public areas, positioned so that junction can be easily reached and size shall be sufficient for purpose (minimum size 12” x 16”). When access panels are required in corridors, lobbies, or other habitable areas, they shall be located as directed by the Architect. Access panels for the electrical installation shall be furnished by the electrical contractor and installed by the General Contractor. Refer to the access door specification in the architectural section for access door specs.

2.28 ELECTRICAL SUPPORTING DEVICES

A. All conduit and fittings on all work are to be secured by one or more of the following:

1. Masonry - metal clips secured by toggle bolts or lead expansion sleeves.
2. Woodwork - metal clips secured by wood screws.
3. Bar joists - wedge hangers.
4. Flanged beams - flange clips.

B. All pipe hangers and equipment supports shall be constructed and installed in accordance with Seismic Zone requirements as outlined in the State Building Code. This Contractor shall submit one (1) copy of shop drawings and calculations detailing seismic hanger restraints to the local Building Authority and Architect, along with a letter of compliance signed by a registered structural engineer confirming that the piping hangers meet State Seismic Code requirements. Cable provided for seismic systems shall be color-coded and pre-stressed.

2.29 Not used

2.30 POWER SYSTEM STUDIES

A. Short Circuits Studies, Protective Device Evaluation Studies, and Protective Device Coordination Studies shall be provided by this Electrical Subcontractor. The studies shall be submitted to the Engineer prior to receiving final approval of the distribution equipment shop drawings and/or prior to release of equipment for manufacture. If formal completion of the studies may cause delay in equipment manufacture, approval may be obtained for a preliminary submittal of sufficient study data to ensure that the selection of device ratings and characteristics will be satisfactory.

B. The studies shall include all portions of the electrical distribution system from the normal power source or sources down to and including the 120/208V distribution system. Normal system connections and those which result in maximum fault conditions shall be adequately covered in the study. The study shall also show senarios with Normal source de-energized and Generator source energized and ATS Transferred to Emergency Terminals. Study done in SKM Power tools preferable.

C. The short circuit study shall be in accordance with ANSI C37.5-1969 (R1975), IEEE std. 320-172 and IEEE std. 1141-1976.

D. The study input data shall include the power company's short circuit contribution, resistance and reactance components of the branch impedances, the X/R ratios, base quantities selected, and other source impedances.

E. Short circuit momentary duty values and interrupting duty values shall be calculated on the basis of assumed three-phase bolted short circuits at each power center bus, distribution panelboards, pertinent branch circuit panel and other significant locations through the system. The short circuit tabulations shall include symmetrical fault currents, and X/R ratios. For each fault location, the total duty on the bus, as well as the individual contribution from each connected branch, shall be listed with its respective X/R ratio.

F. A protective device evaluation study shall be performed to determine the adequacy of overcurrent and switching devices and automatic transfer switches, by tabulating and comparing the short circuit ratings of these devices with the calculated fault currents. Appropriate multiplying factors based on system X/R ratios and protective device rating standards shall be applied.

G. A protective device coordination study shall be performed to provide the necessary calculations and logic decisions required to select or to check the selection of power fuse ratings, protective relay characteristics and settings, ratios and characteristics of associated current transformers, and low voltage breaker trip characteristics and settings. The objective of the study is to obtain optimum protective and coordination performance from these devices.

H. The coordination study shall include all low voltage classes of equipment from the utility's incoming line protective device down to and including the devices in

the 120/208 volt panelboards. The phase and ground overcurrent protection shall be included as well as settings of all other adjustable protective devices.

I. The time-current characteristics of the specified protective devices shall be drawn on Keuffel and Esser log-log paper. The plots shall include complete titles, representative one-line diagram and legends, associated power company's relays or fuse characteristics, significant motor starting characteristics, complete parameters of transformer withstand limits and significant symmetrical and asymmetrical fault currents. All restrictions of the National Electrical Code shall be adhered to and proper coordination intervals and separation of characteristic curves shall be maintained. The coordination plots for phase and ground protective devices shall be provided on a system basis. A sufficient number of separate curves shall be used to clearly indicate the coordination achieved.

J. The selection and settings of the protective devices shall be provided separately in a tabulated from listing circuit identification, IEEE device number, current transformer ratios and recommended power fuse selection shall be provided for the medium voltage fuses where applied in the system. Any discrepancies, problems areas, or inadequacies shall be promptly brought to the Designer's attention.

K. The results of the power system study shall be summarized in a final report. Six (6) bound copies of the final report shall be submitted.

L. Report shall include the following selections:

1. Description, purpose, basis and scope of the study and a single diagram of that portion of the power system which is included within the scope of the study.

2. Tabulations of circuit breaker, fuse and other protective device ratings versus calculated short circuit duties, and commentary regarding same.

3. Protective device time versus current coordination curves, tabulations of relay and circuit breaker trip settings, fuse selection, and commentary regarding same.

4. Fault current calculations including a definition of terms and guide for interpretation of computer printout.

5. The Electrical Subcontractor shall test, calibrate, and adjust circuit breaker trip devices as recommended in the power system study.

Not Used 2.32 FIRE ALARM SYSTEM

A. The fire alarm system including all peripheral devices shall be the standard product of a single manufacturer to match existing. The control panel shall be of the modular construction type with solid state, microprocessor based electronics.

The addressable fire alarm system shall match existing and modifications made per drawings Existing.ExistingARFF

B. Approved Equipment Suppliers

Equipment and materials shall be as manufactured Existingto match Exisitng. Equipment designations and model numbers herein specified are those of ExistingExisting. It will be the responsibility of the electrical contractor to ensure proper specification adherence for system operation, final connection, test, turnover, warranty compliance, and after-market service. The distributor of the equipment specified shall be factory trained and certified. All equipment shall be provided by one manufacturerExisting

C. All substitute equipment proposed as equal to the equipment specified herein, shall meet or exceed the fire alarm equipment standards. For equipment other than that specified, the contractor shall supply proof that such substitute equipment does in fact equal or exceed the features, functions, performance, and quality of the specified equipment.

General

A. Provide complete power limited analog-addressable fire detection and alarm system. System shall include, but not be limited to: modifications to the existing Fire Alarm Control (FACP), Remote Fire Command Center, alarm initiating, horn and visual notification appliances, enclosures and all other equipment necessary to furnish fully operational system. Provide complete system programming, installation, testing and documentation in compliance with all applicable contract documents.

B. Provide alarm detection, horn/visual signaling, status annunciation, municipal notification, and HVAC control per local requirements.

C. Provide an evacuation system in the entire building a code 3 temporal horn signal via the horn/strobe units. Provide the required amplifiers with 100% spare redundancy. System shall be activated by the fire alarm control system.

D.If there are voice Evac and/or Mass Notification system requirements EC is to confirm prior to Bid and include this scope in the bid . this cost may be indicated as a included breakout cost and qualified on proposal.

General Requirements

A. Refer to Part 1 of this Section for information on Substitutions.

B. Final connections, testing, and adjusting of system shall be done under direct supervision of system supplier. Services of trained technician employed by system supplier shall demonstrate system to satisfaction of Owner’s representative, and make additional adjustments to system operation as required

by Owner's representative.

C. System shall be modular to allow future expansion with minimum of hardware additions.

D. It shall be the contractor's responsibility to ensure that all systems are completely functional at the conclusion of this project.

Codes and Standards:

A. System design and installation shall conform to following standards:
   1. Equipment shall be UL listed for its intended purpose.
   2. NFPA Standards 70 (National Electric Code), 72, 90A, 92A, and 101.
   3. Current State Building Code(s).
   4. Americans with Disabilities Act (ADA).
   5. Requirements of Local Authority Having Jurisdiction.
   6. Electrical Code

Quality Assurance:

A. To ensure reliability and complete compatibility, all Items of the Fire Alarm System, including FACPs, power supplies, as well as all initiating and indicating devices, shall be manufactured by Existing. All system components shall be listed by Underwriters Laboratories inc. (UL) and Factory Mutual International (FMI) and shall bear the respective labeling. Partial listing shall not be acceptable.

Submittals

A. In addition to requirements of Part 1 of this Section, furnish following:

   1. Indicate type, size, rating, catalog number, manufacturer's names, and catalog data sheets for all items to ensure compliance with these specifications. Equipment shall be subject to approval and no equipment shall be ordered without prior approval. Equipment and devices are shown on contract drawings.

   2. Furnish calculations to support size of power supplies, audio amplifiers and standby batteries submitted. Calculations shall accommodate voltage drop, wire size, and required spare capacity allowance.

   3. Supply details of any special installation procedures.

   4. Provide complete description of system operation.

   5. Complete point-to-point riser diagram showing equipment and size, type and number of conductors and devices.

6. Provide signal circuit calculations that demonstrate 25 percent spare capacity, adequate wire size and proper consideration of voltage drop characteristics.

7. Large scale drawings of FACP and any other required hardware panels such as auxiliary power supplies, remote panels showing locations, dimensions and field wiring in full detail.

8. Devices and their corresponding addresses shall be shown on floor plans as part of the required documentation. Point identification lists shall be provided during the submittal phase to ensure proper coordination of alarm message text assignments that include each device type, address number and corresponding LCD message text.

9. Operation and maintenance manuals (4 copies).

10. Confirmation that manufacturer's representatives that are factory-trained, certified, and properly licensed will provide job site supervision during system installation, perform final testing and documentation, and instruct Owner's operating personnel on system operation.

11. Complete description of system Sequence of Operation.

12. Provide a copy of the Original Manufacturer’s Warranty Statement.

Equipment Overview:

A. The successful bidder shall furnish and install a complete Existing networked fire alarm system, with all wiring, programming, and connections as described on the drawings and this document. The network system shall be wired in a supervised, 2-wire fashion utilizing Style 7 configuration as per NFPA 72.

B. Catalog numbers specified are those of Existingand constitute type, product quality, material, desired operating features.

C. Fire alarm control panel (FACP) is existing to remain and be modified System shall support full analog functions, automatic system programming, alarm verification by individual device and serial interface to network panels, remote annunciators, printers, and alphanumeric displays as applicable

D. Provide microprocessor based addressable fire alarm system as described herein. Fire alarm control, fire command center, network nodes, annunciator, manual stations, automatic fire detectors, smoke detectors, alarm indicating appliances wiring, terminations, and other necessary materials for complete operating system. System shall be capable of on site programming to accommodate expansion and to facilitate changes in operation. Software operations shall be stored in non-volatile programmable memory within fire alarm control panel. Loss of primary and secondary power shall not erase instructions

stored in memory. Full flexibility for selective input/output control functions based on ANDing, Oring, NOTing, timing and special coded operations shall also be incorporated in resident software programming of system.

E. Network panels shall provide complete peer-to-peer operation, whereby each panel shall support standalone operation, as well as global annunciation and control of each point across network. The network shall be capable of Style 7 wiring, so that in the event of a single open or short on the network loop, will not affect any system operation.

F. Standby batteries shall be capable of supplying system under full supervision for 60 hours. Following 60-hour period, system shall supply 100 percent general evacuation alarm output for minimum of 15 minutes.

G. When AC power is restored, system shall revert back to AC power without operator intervention or manual restart.

H. FACP shall permit overall system monitoring, testing, display, reporting, and firefighter controls to override automatic actions. Panel shall serve following functions:

I. Monitor initiating devices, annunciate device in alarm and its location, capture elevators, notify local authorities, and initiate alarm notification by audible/strobe signaling.

J. Alarm initiating devices shall automatically respond with their condition. Control relays shall be programmed by system to respond automatically in event of alarm of related sensors. After proper passcode clearance, operator shall be able to manually control outputs, review and acknowledge outstanding events, review FACP event log and review FACP status.

K. Components and systems shall be designed for uninterrupted duty. Equipment, materials, and accessories, shall be provided by single U.S. manufacturer, except as otherwise called for in Contract Documents.

L. Initiating and indicating circuits shall be as follows: Circuits and devices shall be electrically supervised. Addressable loop and monitor circuits shall be Class A - Style D. Signaling circuits shall be Class A - Style Z. Monitor modules must be with 3'-0" of the device being monitored. Programmable outputs shall enable required auxiliary control and manual override functions, with corresponding addressable inputs, which will support status feedback. FACP addressable loops, audio and ADA visual control portions of system shall accommodate initiating circuits, indicating circuits and devices shown, allowing minimum of 25 percent spare capacity throughout.

Sequence of Operation:

A. Furnish and install a new EXISTING Devices per fire alarm drawings

B. All alarm, trouble and supervisory signals shall be annunciated on the control panel and fire annunciators. The main FACP and the fire annunciators shall provide the fire department complete control of the fire alarm system

C. The FACP shall trip the exisitng reporting method for the building and activate all new A/V notification devices.

D. During an alarm condition, the EXISTINGexisting FACP shall activate all new A/V signals, and report the incident to the existing fire prevention department. .

E. During a trouble or supervisory condition, the FACP shall activate report to all existing fire prevention responsible parties per the existing methodology.

F. Not Used EXISTINGEXISTING

G. Operation of addressable station or activation of any addressable alarm initiating device (smoke, heat, pull station, duct smoke detector, flow switch) shall automatically:

1. Activate horns using a temporal code 3 signal and synchronized ADA visual alarm strobes throughout building. Upon operation of system silence, audible signals shall silence while visual signals shall continue to operate until system is reset. Restoring circuits to normal after acknowledge button has been operated shall cause lamp to extinguish. Trouble signal shall resound every time new trouble (or supervisory) condition is reported.

2. Display device address, type and location or circuit of initiation via LCD display located at main FACP, remote network panels and system annunciators.

3. Initiate transmission of an alarm signal to Fire Department via existing methodology

4. Visually annunciate device location by building, zone, floor, and device type .

5. Automatically shut down HVAC units.

6. Operate prioritized outputs to release magnetically held smoke doors and magnetically locked doors in building. Release stair door locks, access controlled door locks and fire shutters.

7. Activate exterior red weatherproof beacon.

8. Upon activation of any addressable smoke sensor, system shall shall initiate alarm response as descried previously with addition of following

actions.

9. Operation of system silence switch shall silence all connected audible appliances. In event of subsequent alarm after system silence, FACP shall resound building alarm signals.

10. Audible trouble signal shall be capable of being silenced with trouble signal acknowledge button, but lamp shall not be capable of being extinguished until circuits are normal. Restoring circuits to normal after acknowledge button has been operated shall cause lamp to extinguish. Trouble signal shall resound every time new trouble (or supervisory) condition is reported.

Fire Alarm Control Equipment:

Not Used FACP is existing to remain to be modified ExistingExisting
A. Signaling Line Circuit (Addressable Loop):

1. System shall supply communication with initiating and control devices individually. Devices shall be individually annunciated at control panel. Annunciation shall include following conditions for each point: Alarm, Trouble, Open, Short, Ground, Device Fail/or Incorrect Device, and Device dirty or out of range.

2. Addressable devices shall have capability of being disabled or enabled individually. Up to 198 addressable devices may be multi-dropped from single pair of wires. Systems that require factory reprogramming to add or delete devices are unacceptable. Communication format shall be poll/response protocol to addressable devices and be binary coded digital.

3. Each detector shall be uniquely identified by unique address, which is established via rotary decade switch on each device at time of installation. Use of jumpers or special programming tools to set device address, or extract device data will not be acceptable. Devices that require addresses to be set in the mounting base are not acceptable to due to reliability concerns.

4. Base shall be common to smoke or heat heads. System shall allow Owner to replace detector heads without need for programming, scanning or downloading into device.

5. System shall allow up to 2,500 feet wire length to furthest addressable device. Provide Class A (Style 7 Signaling Line Circuit as defined by NFPA-72) communications.

6. Provide line fault isolator modules installed in manner that shall limit performance degradation in event of short signaling line circuit. A

maximum of twenty-five devices shall be installed between isolator modules. Each addressable loop shall provide a minimum of two individually isolated circuit loop Sections. In the event of failure of one loop Section, the balance of circuit shall continue to operate.

System Annunciation:

A. Not Used.

System Power Supplies:

A. Provide 3.75 amps of 24 VDC system power (minimum) within each transponder panel, with integral battery charger and standby batteries. Battery charger shall support lead acid batteries of up to 31 AH. Provide power supplies to operate system under alarm full load condition with 25 percent spare capacity.

B. Supplementary Notification Appliance Circuit (SNAC) Power Supplies shall be located in the primary electrical closets. Provide 6 amps of 24 VDC remote system power audio/visual devices. The system shall provide four Class A circuits which are individually controlled. The SNAC shall have integral synchronization of the strobe devices (as applicable); the use of external synchronization modules shall not be permitted. Up to 10 SNAC power supplies shall be interconnected to ensure device synchronization over large areas. The system shall transmit any fault conditions back to the main FACP via the addressable loop. Battery charger shall support lead acid batteries of up to 31 AH. Provide power supplies to operate system under alarm full load condition with 25 percent spare capacity.

C. Each floor shall be equipped with a minimum of two notification appliance circuits.

System Devices:

A. Provide analog/addressable devices where shown and required. Each device shall communicate with fire alarm control panel via digital data communications. Where ambient conditions preclude use of addressable devices, equivalent conventional devices shall be used. In this instance, each device shall be monitored by dedicated addressable module that shall be installed in appropriately heated/ventilated space. The following detectors shall be supported:

1. Analog photoelectric smoke detectors
2. Analog thermal 135 F detectors
3. Analog high temperature thermal
4. Analog addressable duct detectors
5. Analog sensors shall have a low profile and be capable of being set at five sensitivity settings of “LOW, LOW MEDIUM, MEDIUM, MEDIUM HIGH, and HIGH” levels.

B. Automatic and manual functional sensitivity and performance tests shall be possible without the need for generating smoke. This method shall test all sensor circuitry and a “Failed Test” indication shall display for any failed test.

C. The system shall check the sensitivity of each sensor periodically. If sensor alarm threshold sensitivity has changed, due to aging and/or dust accumulation, the system shall automatically compensate for this change (drift compensation).

D. Each sensor shall allow for the setting of two sensitivity levels. These levels may be programmed so that when the building is occupied, a sensor will be less sensitive than when the building is unoccupied. This feature permits sensors to be more reliable and at the same time reduces/minimizes unwanted alarms. This feature shall also provide for programmable weekend days, where the sensor will remain at an unoccupied sensitivity level.

E. Sensors shall contain magnetically actuated test switch for easy alarm testing at sensor location. Sensor's electronics shall be immune from false alarms caused by EMI and RFI. The sensor screen and cover assembly shall be removable for field cleaning.

F. Addressable thermal sensors shall have a low profile and operate on the “fixed temperature” principle, or combination fixed temperature rate-of-rise, with the sensor having a set point of 135 o F. They shall contain dual thermistor sensing circuitry for fast response.

G. Provide duct sensor housings where shown. Provide remote test and indicating station near each detector. Provide sampling tubes sized according to duct width. Provide two 10A. 24 VDC contacts in detector. Wire NC contacts in relay to fan motor starter. Where possible, duct detector will be mounted in straight runs of ductwork at least six duct widths downstream from ductwork bends. Coordinate physical location of detector with HVAC and with system equipment representative.

H. The mounting base shall accommodate all models of addressable heat detectors and smoke detectors to ensure matching the proper sensor to the potential hazards of the areas being covered. In all cases the system shall recognize when an improper sensor type has been installed in a previously programmed sensor type location.

I. Addressable Monitor Module, with an initiating circuits wired Class B, Style B shall be furnished to provide two addresses for individual, normally open (N.O.) contact devices.

J. Addressable Monitor Module. An addressable monitor module with an initiating circuit capable of being configured either Class A, Style D shall be furnished to provide an address for an individual, normally open (N.O.) contact de-vice, or a collective address for a group of such devices. The AMM-4 module shall contain

a yellow status LED that shall flash when in a quiescent mode and light continuously when in alarm. Use one module for each tamper, flow or pressure switch.

K. Addressable Sub-Loop Module. An addressable sub-loop module with an initiating circuit capable of being configured either Class A, Style D shall be furnished to provide an address for compatible conventional smoke detectors. The AMM-4S module shall contain a yellow status LED that shall flash when in a quiescent mode and light continuously when in alarm. Use one module for each existing detection zone.

L. Addressable Output Module. An addressable output module shall be connected to the same signaling line circuit as the analog/address-able monitor devices and shall provide a DPDT relay output (2 Form “C” 2 amp @ 24 VDC, resistive only) for the AOM-2R. The AOM-2S shall provide a notification appliance circuit output (1 amp @ 24 VDC, requiring separate power input) or a solenoid energizing circuit or releasing service. The AOM-2R/S module shall contain a yellow status LED that shall flash when in a quiescent mode and light continuously when activated. The LED shall be field programmable not to provide quiescent status indication if so desired.

M. Fault Isolator Module. This module enables part of the signaling line circuit to continue operating when a short circuit occurs on a section of it. An LED flashes in the normal condition and lights during a short circuit condition. The module automatically restores the entire circuit to the normal condition when the short circuit is removed. This module may be used in multiple in any combination with other modules, providing circuit operation is similar to that of NFPA Style 7. It does not require an address on the signaling line circuit.

N. Provide double action addressable pull stations with electronics that communicate station's status (alarm, normal) to control panel over two wires which also supply power to pull station. Address shall be set on each station and status LED shall be visible from front of device. Stations shall be manufactured from high impact red Lexan. Lettering shall be raised and painted white. Station shall mechanically latch upon operation and remain so until manually reset by opening with key common to all system locks. A key shall be required to reset and shall be keyed alike with the control cabinet. For weatherproof applications, Model MS-7LOB shall be used with an addressable module.

O. Provide Class A addressable monitoring module where required to supervise conventional initiating devices such as waterflow, tamper switches or beam detectors. Modules shall also be used for status monitoring of related systems such as HVAC units.

P. Provide remote addressable control modules, AOM Module where required to conduct remote control functions or outputs. Remote control modules shall provide form C contact output rated for 2 amps at 24 VDC.

Q. Provide combination horn/strobe units or visual only units where indicated. Visual units shall consist of 24V with Led or Xenon Flasher in clear lens. Word "FIRE" shall be imprinted in bold white lettering. Light output shall be field selectable with settings of 15, 15/75, 30, 75, and 110 candela. Devices that are not field adjustable will not be accepted. Where two or more strobes are within in common field of view, all strobes shall be synchronized.

R. Furnish and install magnetic door holders for all fire and smoke doors and all other locations shown on contract drawings.

S. Not Used

T. Not Used

U. The Electrical Contractor shall provide the required fire alarm control/monitor modules, cable, conduits and fire alarm system programming to provide NFPA 72 required supervisory and monitoring System and signal booster supervisory signals shall include the following:
(a) Antenna malfunction
(b) Signal booster failure
(c) Power supply supervisory signals shall include the following for each signal booster:
(d) Loss of normal ac power
(e) Failure of battery charger
(f) Low-battery capacity, alarming at 70 percent of battery capacity

Spare Parts:

A. The following equipment shall be provided as spare parts to the owner and stored on-site in original sealed containers:

1. Ten smoke detectors with mounting bases
2. Three heat detectors with mounting bases
3. Five addressable pull stations
4. Five Speaker/strobe units with adjustable candela
5. Five strobe only units with adjustable candela

System Accessories:

A. Not Used

B. Provide flashing weatherproof strobes where shown, (red) for alarms

C. Provide key box repository (minimum size Knox Box 4400 series or approved equal), type and location to be approved by local Fire Department.

D. Furnish and install flush mounted electromagnetic door holders where shown and indicated. Device shall operate on power supplied from fire alarm control panel. Under normal conditions, magnets shall hold door open. Upon activation of building fire alarm system, devices shall be de-energized, thus releasing doors

on circuit. Devices shall be designed for wall or floor mounting as required by location shown on drawings, complete with matching door plate, material and finish to match door hardware. Electromagnet shall operate from 24 VAC.

System Programming:

A. System shall be software configured on site via laptop computer. Complete software configuration shall be constructed on computer without need for connection to system.

B. Fire detection and alarm system shall permit system revision and expansion to be completed on site. Under no circumstances shall system's site specific configuration program be required to be returned to manufacturer for modification as result of system expansion or revision.

C. The electrical contractor shall include two additional programming sessions to make changes to the fire alarm program per the required changes made by the fire department. This scope of work shall include the required labor by the electrical contractor and the service company.

D. Configuration shall be stored on standard USB for subsequent downloading to Fire Alarm Control Panel (FACP). USB configuration shall contain installation name and specific configuration revision number. Revision number shall allow for tracking of system modifications throughout life of system. Provide one copy of the USB with the O&M manuals and one inside the FACP including password. Each revision of system configuration on USB shall include following information.

1. Date/time of modifications to configuration.
2. Description of changes made to system.
3. Identification of programmer who input program revisions.
4. Installation shall be supervised and tested by equipment supplier. Work shall be performed by skilled technicians under direction of experienced engineers, all of whom shall be properly trained and qualified.

Wiring:

A. Wire and cable for fire alarm systems shall be solid color coded, copper conductors, power limited, UL listed type FPL plenum rated, 105 degrees C, with red jacket and labeled as complying with NFPA 70, Article 760, and as recommended by manufacturer.

B. Signaling Line Circuits (Addressable Loop): Twisted, unshielded pair, minimum No. 16 AWG or as recommended by system manufacturer.

C. Strobe Circuits: Unshielded twisted pair, minimum No. 14 AWG, or as recommended by system manufacturer.

D. Audio Circuits: Twisted, shielded pair, minimum No. 16 AWG, or as

recommended by system manufacturer.

E. Wiring for system shall be in accordance with Articles 760, 725, and 800 of National Electrical Code and local electrical codes.

F. Where cable is run in pipe or tubing, pull boxes shall be painted red, and four inch wide red stripe shall be painted on pipe or tubing every ten feet such pipe ort tubing is exposed. Fire alarm cable in raceways shall be tagged every 20 feet.

G. Provide plenum fire alarm metal clad cable for runs concealed in ceiling and walls. Cables may be run longitudinally or laterally throughout the ceiling. Provide EMT raceways where run exposed, where run within walls or in inaccessible ceilings.

H. Wiring of audio circuits shall maintain minimum 12 inch separation between supply and return circuits.

I. Provide rigid steel conduit at exterior locations and for all vertical runs between floors.

J. Provide complete wiring and conduit between all equipment. Devices shall be mounted upon and terminations made in UL boxes. Wiring splices and transposing or changing of colors will not be approved.

K. Junction boxes shall be painted red with gasketed cover, and labeled as 'FIRE ALARM SYSTEM'.

L. Fire alarm control systems and equipment shall be connected to separate dedicated branch circuits, sized for proper service. Circuits shall be labeled 'FIRE ALARM'.

Final Test (Pre-acceptance Test):

A. During final testing, sound level measurements shall be taken and recorded in each occupied space. System shall produce 75dbA, or 15dbA above ambient (whichever is greater. Following initial measurement, necessary adjustments shall be made to each speaker setting to ensure compliance with Contract Documents and applicable code.

B. Perform complete final test of system indicating proper functioning of system. Furnish copies of completed NFPA 72 system Certificate of Completion in accordance with NFPA 72 to Owner and Architect for documentation and record purposes.

C. In addition to pre-acceptance test, Contractor shall provide for complete and final Fire Department Acceptance Testing in accordance with requirements of Authority Having Jurisdiction and applicable code.

Fire Alarm Inspection and Testing Contract:

A. Provide Certificate of Completion indicating proper functioning of system as well as certification/acceptance by Fire Department, in accordance with NFPA 72.

B. Prior to making final connections, system supplier shall furnish contract to Owner for fire alarm system inspection and testing contract in compliance with NFPA-72. Testing Contractor shall be trained and certified by original manufacturer to be a holder of a certificate of competency as Fire Alarm System Contractor from Fire Department, and be responsible for inspection, testing, and maintenance of interior fire alarm system for duration of original manufacturer's warranty period. Contract shall be for guarantee period with option to extend by Owner.

C. Submit to Fire Department signed and executed documentation verifying that entire fire alarm system has been tested in accordance with NFPA 72 and Underwriters Laboratories guidelines. Also, copy of signed and executed contract for periodic testing shall be provided to Fire Department prior to requesting their services for acceptance testing.

D. As part of the base bid, a one (1) year service contract shall be included. The manufacturer of the fire alarm system shall guarantee all equipment and the functional operation of the system for a period of one (1) year from the date of final acceptance. During the one year guarantee period, the fire alarm system manufacturer or his authorized representative shall respond within twelve (12) hours after notification of any malfunction.

E. The programming of the fire alarm system shall be in accordance with the operational requirements of ARFFthe Fire Department. After the system has been completely installed and in operation, all parties shall meet to determine if the initial programming should be adjusted for oversights or that changes should be made to the operational procedures. The ARFFARFFshall be provided with two (2) additional programming sessions to make any and all changes to the system accomplish the desired operation. Program changes shall be done without additional cost to the Owner. The Electrical Contractor shall furnish and install self adhesive labels showing the address number for all initiating devices.

F. Test reports shall include following information:

1. Date of test
2. Name and location being tested
3. Number of interior alarm circuits
4. Number of devices tested and type
5. Condition of emergency standby power supply
6. Conditions of analog sensors - report shall identify any analog smoke detectors that are contaminated and approaching a trouble (dirty) state. After first year of operation, each and every analog sensor shall be cleaned and recalibrated in accordance with NFPA 72 testing and

maintenance guidelines.
7. Name of company conducting test
8. Name and signature of person conducting test

Training:

A. Provide services of manufacturer's representative for period of up to 8 hours, during normal business hours, to instruct Owner's designated personnel on operation and routine maintenance of system.

2.31 LIGHTING CONTROL

A. SYSTEM DESCRIPTION - The lighting control system shall be as indicated on the drawings and to match the existing lighting control methodology currently in building.

B. MANUFACTURERS – Shall match drawing details and the existing manufacturers.

C. Shop Drawings - Product Datasheets (general device descriptions, dimensions, wiring details, nomenclature)**.** Riser Diagrams – typical per room type (detailed drawings showing device interconnectivity of devices)**.** Other Diagrams – as needed for special operation or interaction with other system(s)**.** Example Contractor Startup/Commissioning Worksheet – must be completed prior to factory start-up**.** Hardware and Software Operation Manuals**.**

D. QUALITY ASSURANCE - The installing contractor shall be responsible for a complete and functional system in accordance with all applicable IECC and local and national codes. All applicable products must be UL and CUL or CSA Listed. Provide a full 5 year warranty.

E. GENERAL SYSTEM SPECIFICATIONS

1. All switching relays shall be located within either a sensor device, single gang wall switch device, or power (relay) pack device.
2. All switching and dimming for a specific lighting zone shall take place within the devices located in the zone itself (i.e. not in a remotely located device).
3. System shall have a primary room controller or wall mounted control device that is capable of accessing and controlling all other system devices in the space and provides manual shut off in the space as well as sensor automatic timed out function fror when space is not occupied. .

F. Not Used LIGHTING CONTROL PROFILES

G. COMMISSIONING FEATURES

1. To facilitate commissioning, all devices daisy-chained together (using CAT-5) shall automatically be grouped together into a functional lighting control zone.

2. All lighting control zones shall be able to function according to default settings once adequate power is applied and before any system software is installed.

2.33 Not Used LIGHTNING PROTECTION SYSTEMS

PART 3 – EXECUTION

3.01 GENERAL NOTES

A. All materials specified in this Section occurring in acoustical ceilings shall be supported directly from the building structure. The acoustical ceiling system shall not be required to support any item specified in this Section of these Specifications.

B. No wire shall be pulled into the conduit system until it is complete in all details. In the case of concealed work, no wire shall be pulled into the conduit system until all rough plastering is completed. The ends of the conduit shall be tightly plugged to exclude dust, moisture, plaster or mortar while the building is under the process of construction.

C. Knockouts in a junction box on any electrical system shall not be left open and junction boxes not having equipment mounted on them shall be capped.

D. Furnish black laminated (white center) identification markers for each disconnect switch, motor starter, panelboard, remote control switch and any other electrical item requiring identification as to its use. Type all panel schedules to indicate utility of each circuit. All nameplates shall be fastened to each piece of equipment with screws.

E. All branch circuit wiring for light and power shall be #12 AWG, unless otherwise indicated.

F. Verify all measurements and job conditions at the building and report any discrepancies before starting the work. The responsibility for coordinating the electrical work with that of the other mechanical trades shall be part of this Section.

G. All conduit shall be of the size required by the Electrical Code for the number of wires indicated.

H. Conduit runs are shown diagrammatically. The exact locations shall be determined on the job. Exposed conduit shall be installed parallel with or at right angles to the building walls and beams. No diagonal runs shall be allowed on exposed work.

I. The Plans indicate the desired location of lighting fixtures. If an indicated fixture location proves to be impractical because of interferences of other mechanical trades, the Architect shall be consulted to determine an alternate location.

J. The exact mounting height of all exit signs and stem-supported lighting fixtures shall be determined on the job by the Architect.

K. A pulling-in wire consisting of a nylon cord of sufficient strength shall be installed

in each spare or future conduit for the convenience of installing future cables.

L. Where 120-volt lighting branch circuit home runs exceed fifty (50) feet and where 277-volt lighting branch circuit home runs exceed one hundred (100) feet to the first outlet, #10 AWG shall be installed.

M. Check all door swings on the Architectural Drawings and if not in accordance with those shown on the Electrical Drawings, the switches for control of the lights shall be located to conform to the door swings shown on the Architectural Drawings.

N. Furnish and install all line safety switches, all necessary mechanical support channel for the mounting of starters and disconnect switches, for heating, ventilating, air conditioning and plumbing equipment.

O. Receptacles in toilets and dishwashing areas shall have gasketed covers.

P. Refer to all Architectural Detailed Drawings for exact location and mounting height of wall receptacles and outlets.

Q. All junction and pull boxes indicated on the Drawings or required for the installation of the work shall be of a size required for the particular installation. Boxes shall be code gauge and shall be painted to match the surrounding architecture wherever required by the Architect.

R. All conduit that is installed exposed on the structural ceiling or above hung or furred ceilings shall be properly supported with approved type supports from the building structure. Conduits supported from pipes or ducts will not be allowed.

S. Expansion fittings shall be installed where conduits are concealed in concrete and cross a building expansion joint. These fitting shall be manufactured by O.Z. Gedney Company or approved equal.

T. Electric metallic tubing (EMT) shall be installed only in furred ceilings and shall be used on exposed work only where such exposed work is protected from mechanical injury. Electric metallic tubing shall not be used in concrete work or in wet areas. Electric metallic tubing turning down from suspended ceilings into block or plaster walls shall be continued to the outlets.

U. Rigid steel conduit shall be installed in wet areas, underground, on exposed work where such work is subjected to mechanical injury and concrete encased ductlines wherever indicated on the Electrical Drawings. All conduit installed in mechanical areas shall be rigid steel. Rigid steel conduits turning up thru concrete slabs into block, plaster or gypsum walls shall be continued to the first outlet. No rigid steel conduit will be allowed in any concrete floor slab. All branch circuit conduits installed under the first floor concrete slab on grade shall be rigid steel. PVC conduits containing branch circuit wiring will not be allowed under any floor slab. No conduits shall be installed within in any concrete floor

slab.

V. All motors shall be furnished and set in place by the Contractor furnishing the same. The Electrical Subcontractor shall furnish and install all magnetic starters, all disconnect switches, and all power wiring from the power panels to the motors. Connections to the motors shall be made with liquid-tight, flexible metal conduit.

W. Refer to the architectural and kitchen equipment drawings for the exact location of all kitchen equipment. Furnish and install all line wiring, receptacles, flexible conduits and connections as required for each piece of kitchen equipment.

X. Refer to the Architectural Reflected Ceilings Plans for the exact location of recessed fixtures in tile ceilings.

Y. In all finished areas, the Architect shall determine the exact location and mounting of each item of electrical equipment.

Z. Any access doors that may be required to provide access to any concealed pull box, junction box, etc., shall be furnished by the Electrical Subcontractor for installation by the appropriate Contractor.

AA. The Electrical Subcontractor shall touch up with matching paint, all electrical equipment scratched or chipped during installation.

BB. Openings around electrical penetrations through fire-resistance rated walls, partitions, floors, or ceilings shall be firestopped by the Electrical Subcontractor using approved methods to maintain the fire-resistance rating.

CC. It is the intent of these drawings for all rigid steel conduit or electrical metallic tubing installed in finished areas without ceiling shall be coordinated with the Architect prior to installation.

3.02 LIGHTING SYSTEM

A. Provide and install a complete lighting system from the lighting panels to the outlets on the lighting system, including wire, conduit, feeders, outlet boxes, junction boxes, receptacles, switches, lighting fixtures and lamps; all as required for a complete lighting system as shown on the Drawings and as described in these Specifications.

B. The branch circuit wire shall be #12 AWG or larger from the lighting cabinets to the outlets and shall be concealed in the building structure where provisions have been made in the structure for the installation of the conduit.

C. All standard catalogue listed lighting fixtures shall meet all the requirements of the Underwriters' Laboratories, Inc., as to heat limitations, wiring, and general construction and shall be so labeled. All special lighting fixtures shall be

manufactured to satisfy the requirements of the Underwriters' Laboratories, Inc., with respect to heat limitations, wiring and general construction

D. The switches and receptacles shall be of the type and capacity called for on the Drawings and specified under the "Products" Section of these Specifications. The exact location of all switches and receptacles shall be determined from the Architectural Detailed Drawings. The drawings indicate the type of lighting fixtures and equipment required at each location.

E. Where recessed lighting fixtures are to be installed in gypsum wall board or acoustic ceilings, plaster frames, finish trim, fittings, and supports shall be furnished and installed under this Section to meet the architectural and structural conditions at the location.

F. Included in the installation of lighting fixtures and lighting equipment shall be the adjustment of the positions of the lighting fixtures, and modifications to reflectors and lamps for appearance, quality, intensity, direction and effect to the satisfaction of the Architect.

G. Fixture parts shall be made of aluminum, brass, bronze, copper, steel or other materials as required by the manufacturing processes involved in each particular fixture part. In cases where aluminum members are fastened to steel or other dissimilar metal parts, the aluminum shall be separated from such parts by a heavy coating of aluminum paint on the contact surfaces of the metal and allowed to dry before assembling.

H. Aluminum sheet, when placed in contact with brick, gypsum, concrete or similar construction shall be back-painted before the installation.

I. Consult the Architectural Drawings to determine the ceiling heights where hanging fixtures are to be installed. Stems shall be cut to the proper length before installation.

J. Upon completion of this installation of the lighting fixtures and lighting equipment and at the time of final inspection, all fixtures and equipment must be clear and free from defects; and any reflectors or glassware broken prior to the final inspection shall be replaced.

K. All flush fixtures shall be centered in the architectural treatment and leveled exactly with the finished ceiling. If the lighting fixtures do not center properly, they shall be relocated to conform to the architectural design of the area. Where flush fixtures are indicated on the Drawings, access outlet boxes shall be furnished and the necessary wire installed in flexible metal conduit between the recessed fixture and the outlet box to make a complete metallic connection between the fixture and the outlet box.

L. All lighting fixtures specified in this Section occurring in acoustical ceilings shall be supported directly from the building structure. The ceiling system shall not be

required to support any lighting fixtures, unless otherwise shown on the Drawings.

M. All lighting fixtures shall meet the requirements of the IECC 2021 Energy Code.

N. Electrical Subcontractor shall assume all responsibility for the safe handling of all lighting fixtures which are furnished under this SECTION and other accessories and lamps until the final inspection has been made by the Architect.

O. Special fittings and materials that may be required to support fixtures shall be supplied as well as supports or grounds required to secure surface or pendant mounted fixtures on suspended ceilings unless otherwise noted. Fixtures shall be supported from the structural floor or roof above, independent of furred or suspended ceilings, unless otherwise indicated. This support shall be in addition to regular fixture support bars, saddles, etc. LED fixtures mounted in association with suspended or integrated ceiling systems shall be supported above ceiling by threaded 1/4 diameter continuous galvanized steel hanger rods or #12 jack chain. Each such fixture shall have two supports per fixtures. Where duct work, pipes, type of building construction materials and structural framing members provide obstructions or difficult support means, hanger rods shall be used in association with horizontal sections of steel support channels in an approved manner. Steel support channels shall be Unistrut, Kindorf, Huskey Products, or equal. Rigid steel conduit may be used instead of steel support channels as approved by Architect for size and method of support. Exact mounting height of all stem supported lighting fixtures shall be determined on the job by Architect.

P. Fixtures, part or parts thereof (including LED driver) determined defective upon completion of electrical installation shall be replaced by Electrical Subcontractor, at no cost to Owner.

Q. Consult with General Contractor regarding arrangement of framing members to permit centering of recessed fixtures.

R. Consult with ceiling subcontractor and coordinate fixture locations and supports with suspended ceiling system.

S. Electrical Subcontractor shall be responsible for furnishing the specified recessed fixtures with proper mounting arrangement to be compatible with the type of ceiling construction in which fixture is to be mounted. If necessary, the type mounting arrangement shall be changed from that specified or indicated on fixtures schedule to conform to this requirement, at no additional cost to Owner. Submission of shop drawings of such recessed fixtures shall be interpreted to indicate that Electrical Subcontractor has verified ceiling construction, type and material with the Architect for the various areas of the project in which these fixtures shall be mounted. Shop drawings of such fixtures shall be accompanied by a written statement indicating Electrical Subcontractor has verified such mounting arrangements with Architect and the date verified.

3.03 POWER SYSTEM

A. The power system wiring shall consist of THWN insulated wires of the size specified on the Electrical Drawings and the type specified in the "Products" Section of these Specifications. Install these wires in conduit from the power panels to the motors, including connections to the magnetic starters and disconnect switches.

B. All automatic temperature control wiring, including wiring for all control devices shall be furnished and installed under the Heating, Ventilating and Air Conditioning Sections of these Specifications, unless otherwise indicated on the Electrical Drawings.

C. All electrical interlock wiring and remote control wiring required for the Heating, Ventilating, Air Conditioning and Plumbing Systems shall be furnished and installed under the Electrical Section to the extent shown on the Electrical Drawings. All interlock and control wiring not specifically shown on the Electrical Drawings, but required for a correct operation of the Heating, Ventilating, Air Conditioning and Plumbing Systems shall be included as work under the Heating, Ventilating, Air Conditioning and Plumbing Section of these Specifications.

D. All control devices, including thermostats, pneumatic-electric switches, electric-pneumatic switches, aquastats, fire detection thermostats, flow switches, freeze protection controls and alternators required for the automatic temperature control system shall be furnished and installed under the Heating, Ventilating and Air Conditioning Section of these Specifications, unless otherwise indicated on the Electrical Drawings.

E. The Electrical Subcontractor shall obtain wiring diagrams of all pieces of equipment to which he must wire. Any discrepancies between these wiring diagrams and the wiring indicated on the Electrical Drawings shall be called to the attention of the Engineer as soon as possible.

F. Furnish and install the power system as indicated on the Electrical Drawings from the power panels to the roof exhaust fans, exhaust fans, air handling units, energy recovery, roof top units, return fans, pumps, chilled water pumps, condenser water pumps, hot water pumps, supply fans, chiller, electric unit heaters, unit heaters, cabinet unit heaters, boiler burner motors, duplex sewage ejector pumps, duplex sump pumps, hot water circulating pumps, duplex domestic water heaters including feeders, power panels, motor disconnect switches and motor starters (except that where starters are an integral part of a motor "Package Unit" these starters will be furnished by the supplier of the motor and installed by the Electrical Subcontractor).

G. Furnish and install all power wiring, magnetic or manual starters and disconnect switches for all pumps, roof exhaust fans, hot water pumps, chilled water pumps, return fans, air handling units, supply fans, unit heaters, air handling units and

cabinet unit heaters. All electrical interlock wiring and remote control wiring shall be furnished and installed by the Electrical Subcontractor, unless otherwise noted on the Electrical Drawings. All automatic temperature control wiring for these units shall be furnished and installed under the Heating, Ventilating and Air Conditioning Section of these Specifications.

H. Furnish and install all power wiring and disconnect switches for roof top units supply and return fans. Furnish and install all power wiring and disconnect switches for air handling units supply and return fans. Furnish and install all power wiring and disconnect switches for heat recovery units supply and return fans. The variable frequency drives (VFD) for these units shall be furnished under the HVAC section and installed and wired under the Electrical Subcontract. If VFD's are not furnished by HVAC for any HVAC equipment, the Electrical Subcontractor shall furnish and install all required magnetic starters.

I. Furnish and install the power wiring and fused disconnect switch for the chiller unit. All control panels and magnetic starters for this unit shall be furnished and installed by the Heating, Ventilating and Air Conditioning Subcontractor and wired by the Electrical Subcontractor.

J. Furnish and install all power wiring and disconnect switches for the duplex domestic hot water heater and hot water circulating pumps, including connections to the respective aquastats. The control wiring for all plumbing motors shall be included in the electrical work to the extent shown on the Electrical Drawings. All control wiring not specifically shown on the Electrical Drawings but required for the correct operation of the plumbing system shall be included as work under the Plumbing Section of these Specifications. Also provide a 120-volt control circuit for each water heater.

K. Furnish and install all power wiring, disconnect switches and magnetic starters for the boiler burner motors. All control panels shall be furnished and installed by the HVAC Subcontractor and wired by the Electrical Subcontractor. Also provide a 120 volt control circuit for each boiler control panel.

L. Furnish and install the power wiring and disconnect switches for each of the electric unit heaters. The electric unit heaters and associated line voltage thermostats shall be furnished and installed by the HVAC Subcontractor and wired by the Electrical Subcontractor.

Q. Provide and install a motor disconnect switch for each motor furnished on the job by the other Subcontractors and sized for the particular motor unless otherwise indicated on the Electrical Drawings.

R. Furnish and install the power wiring, fused disconnect switch with auxiliary switches for the elevator motor including the signal circuit fused disconnect switch. Provide and install wiring from the load side of the elevator disconnect switch to the line side of the elevator control panel. Provide and install a junction box in the elevator machine room for lighting and telephone connections.

Furnish and install a duplex ground fault receptacle and a wall mounted lighting fixture with guard and 100 watt lamp in the elevator pit. The permanent electric service shall be installed in a timely manner so that the permanent electric service can be used to install the elevator.

S. Power wiring shall terminate in a junction box adjacent to each motor. Furnish and install power wiring in a liquid-tight flexible conduit from this junction box to the power terminals of each motor with flexible length not to exceed six (6) feet.

T. The emergency system feeders shall be installed in accordance with the requirements of the Electrical Code, Article 700-10. The emergency system feeders shall be mineral insulated type MI cable with a 2-hour fire resistive rating.

3.04 LIGHT AND POWER DISTRIBUTION SYSTEM

A. Furnish and install a complete light and power distribution system from the main secondary switchboard to the power and lighting panels, including wire, conduit, power and lighting panelboards and cabinets.

B. Provide and install the power and lighting panels of the type specified under the "Products" Section of these Specifications and with the number and ratings of circuits shown on the Schedules.

C. Provide and install the power and lighting feeders to the power and lighting panels. Feeder conduits installed in concrete, wet areas, underground or subjected to mechanical injury shall be rigid steel. Feeder conduits installed in furred ceiling areas, partitions or exposed on walls, and ceilings in dry areas, shall be electrical metallic tubing. PVC conduits containing light and power feeders may be installed under the first floor concrete slab. PVC feeder conduits will not be allowed in any concrete floor slab.

3.05 ELECTRICAL CHARACTERISTICS

A. The electrical characteristics of the primary electric service will be 25 KV, 3-phase, 3-wire, 60-hertz.

B. The electrical characteristics of the secondary electric service shall be 208/120 volts, 3-phase, 4-wire, 60-hertz

C. All motors furnished under the Heating, Ventilating, Air Conditioning, and Plumbing Sections of these Specifications ½ HP and larger shall be designed to operate on the 208 volts, 3-phase, 3-wire, 60-hertz service. All motors under ½ HP shall be designed to operate on the 120 volt, single phase, 60-hertz service or per drawings

D.

E. All LED LED lighting fixtures shall be designed to operate on the 480/277-volt, 3-

phase, 4-wire, 60-hertz system.

F. All incandescent lighting fixtures and receptacles shall be designed to operate on the 208/120 volt, 3-phase, 4-wire, 60-hertz system.

3.06 GROUNDING

A. The electrical installation shall be a continuously bonded system through the conduit system from the equipment ground bus in the main switchboard. All couplings, locknuts, and bushings shall be drawn-up tight to the satisfaction of the authority enforcing the Electrical Code. All cabinets and equipment shall become a part of the bonded system. It shall be the responsibility of the Electrical Subcontractor to test the continuity of the bonding system.

F. Wherever indicated on the Electrical Drawings, receptacles shall be properly bonded to the green insulated copper ground wire installed in the conduit containing the circuit conductors. This ground wire shall be connected to the equipment ground bus in the respective panelboards and shall be #12 AWG unless otherwise noted on the Electrical Drawings.

G. Wherever indicated on the Electrical Drawings, the equipment ground bus located in the various panelboards shall be connected to the equipment ground bus in the main switchboard located in the electric room with an insulated copper wire of the size shown on the Electrical Drawings. This ground wire shall be installed in the conduit containing the feeder conductors.

3.07 TEMPORARY LIGHT AND POWER

A. The Electrical Subcontractor shall provide temporary electric service feeders of sufficient capacity from the Utility Company's primary electric service from the nearest street for the light and power requirements of this building during the construction period.

B. All poles, high voltage cable, transformers, metering equipment, disconnect switches, panelboards, cables and junction boxes required for the temporary electric service shall be furnished and installed by the Electrical Subcontractor.

C. The Electrical Subcontractor shall consult with the Utility Company to determine the best location to install the temporary electric service feeders and metering equipment. All charges of the utility company pertaining to the temporary electric service installation shall be paid for by the Electrical Subcontractor.

D. Temporary light shall be based on one - LED lamp that is the equivalent of (1) 200 watt lamp covering 100 square feet of floor area in the building, and sufficient wiring and outlets shall be installed to insure proper lighting in all stairwells and public corridors. The temporary wiring and lamps required for this general lighting shall be paid for by the Electrical Subcontractor, including the cost of lamp replacement. All temporary lighting lamps shall be either - LED.

E. The Electrical Subcontractor shall install and maintain on each floor of the building, a feeder of sufficient capacity for the requirements of each area and covering the entire length of the building, and provide sufficient number of outlets, located at convenient points, so that extension cords of not over fifty (50) feet will reach all work requiring artificial light and power. Subcontractors of all other trades shall furnish their own extension cords, sockets, lamps as may be required for their work, and shall also pay the cost of all temporary wiring of construction offices or trailers used by them.

F. All temporary electrical work shall be furnished and installed in conformity with the Utility Code and in accordance with the requirements of the local ordinances.

G. Any temporary wiring of a special nature that is required for the building during the construction period other than mentioned above shall be paid for by the Contractor using same.

H. The General Contractor shall pay the cost of the electrical energy consumed by all trades during the construction period.

I. As soon as the permanent electric service has been installed, the temporary electric service from the Utility Company's power lines may be removed and the permanent service may be used. The General Contractor shall continue to pay the cost of electrical energy until the building has been accepted by the CITY of NEWTON.

J. All temporary electric work installed during the construction of this building shall be removed by the Electrical Subcontractor. This includes all poles, transformers, meters, cables, conduit, panelboards, disconnect switches, branch circuit wiring, etc.

K. All temporary lighting required during the construction period shall be in accordance with the Occupational Safety and Health Administration's latest requirements for "Safety and Health Regulations for Construction". The Electrical Subcontractor shall provide the minimum lighting intensities in all areas of construction as required by these regulations.

M. All temporary portable lighting fixtures required to provide adequate lighting for the painting of the numerous rooms throughout the building shall be furnished by the Painting Subcontractor. These portable lighting units shall be furnish with extension cords of not more than fifty (50) feet in length. The Electrical Subcontractor shall provide a sufficient number of outlets at the required locations for these portable lighting units.

N. Refer to Section 015000.

3.08 EMERGENCY ELECTRICAL SYSTEM

A. Furnish and install a complete emergency system, including wire, conduit, outlets, lighting fixtures, exit lights, panelboards and cabinets, transfer switches, contactors, supervisory relays, engine generator units, and distribution panelboards.

B. The Existing engine generator unit shall automatically start and supply energy to those lights and items of equipment designated to be on the emergency system, whenever the normal source of energy to the building has failed and when any of the area protection relays have operated.

C. Not Used

D. Lighting fixtures designated to be on the emergency system shall not be subjected to any type of switch control when operating on the emergency generator, except the transfer arrangement and branch circuit protective devices.

E. The emergency lighting branch circuits shall be connected to the emergency lighting panels via single pole switches, three and four way switches and the by-pass relays. Furnish and install relay cabinets with contactors to by-pass all switches during emergency conditions. The relay cabinet shall monitor the normal lighting circuit in the area being served by emergency lighting. Whenever the contactors in the relay cabinets are closed, all emergency lighting fixtures shall come "ON" if "OFF" and remain "ON" if already "ON". Refer to the emergency relay cabinet detail and schedule on the Electrical Drawings."

F. The Electrical Drawings show certain lighting fixtures to be on both the "Normal" and "emergency" systems. Under "Normal" conditions, these lights may be subject to dimmer or manual switch control. If the normal power should fail, the emergency generator shall automatically start and all "Normal-Emergency" lights shall automatically become energized to full brilliancy whether or not they were before the emergency existed.

G. Emergency lighting fixtures, panelboards, cabinets, switches, conduit and wire shall be as specified for the normal lighting system.

H. All emergency electrical system feeders located outside of the emergency generator room shall be part of an assembly which has a 2-hour fire resistive rating and shall be in conformance with Article 700-10 of the Electrical Code. All emergency system feeders shall be type MI, mineral insulated, metal sheathed cable with solid copper conductors. The cable shall be classified by Underwriter's Laboratories, Inc. as having a two (2) hour fire resistive rating. To comply with UL requirements, cable supports shall be provided every three (3) feet on horizontal runs and every six (6) feet on vertical runs.

I. The complete legally required standby systems and standby systems electric systems including transfer switches, distribution panels, transformers, power panels, feeder, conduit and wire shall be installed in accordance with Electrical Code Article 700 and Article 702.

3.09 Not Used SWITCHGEAR ACCEPTANCE TESTS

3.12 SEISMIC SUPPORTS, SUPPLEMENTARY STEEL AND CHANNELS

A. Provide all supports, supplementary steel and channels required for the proper Seismic installation, mounting and support of all work installed under this Section.

B. All supports, supplementary steel and channels shall be furnished, installed and secured with all fittings, support rods and appurtenances required for a complete support or mounting system.

C. Supplementary steel and channels shall be firmly connected to the building construction in a manner approved by the Architect prior to the installation of same. Submit to the Architect, via the General Contractor, the locations proposed for using supplementary steel and channels for the support of equipment, fixtures and raceways. The submittal shall indicate the mounting methods, size and details of the supports, channels and steel; it shall indicate also that weight which the supports, channels and supplementary steel is to carry.

D. The type and size of the supporting channels and supplementary steel shall be of sufficient strength and size for seismic restraint and to allow only a minimum deflection in conformance with the channel and supplementary steel manufacturer's requirements for loading.

E. All supplementary steel and channels shall be installed in a neat and workmanlike manner parallel to the walls, floor and ceiling construction. All turns shall be made with 90 degrees and 45 degrees fittings, as required to suit the construction and installation conditions.

F. All supplementary steel, channels, supports, and fittings, shall be Underwriters' Laboratories, Incorporated, approved, be galvanized steel and be manufactured by Steel City, Unistrut, Power-Strut, T. J. Cope, Chalfant or approved equal.

G. Provide supports to meet the required Seismic rating as required. Equipment and work shall meet the restraint requirements for a Seismic Zone - 2 location including installation and connections of material and equipment to the building structure.

H. Provide beam clamps with set screws (C-clamp type).

I. Work under this Section shall be held in place by Seismic rated methods.

J. Supporting from the roof decking will not be acceptable.

K. Provide expansion anchors on masonry units or brick work. Power actuated supports will not be accepted.

L. Provide stainless steel or corrosion resistant supports in corrosive areas on wet or damp areas.

M. Support work from the building structure, independent of suspended ceilings, roof deck or other trades work. Where duct work, pipes, pipe racks, type of building construction materials or structural framing members provide obstruction or difficult support means, hanger rods shall be used in association with horizontal sections of steel support channels, in an approved manner.

N. All work shall be installed in a rigid and satisfactory manner and shall be supported by bar hangers in frame construction or shall be fastened directly with wood screws on wood, bolts with expansion shields on concrete or brick toggle bolts on hollow masonry units, and machine screws or welded threaded studs on metal. Threaded studs of the proper type and holding capacity driven in by a power charge and provided with lock washers and nuts are acceptable for mounting of equipment on solid concrete walls or slabs.

O. Obtain written permission from the General Contractor allowing use of power activated charges. Use only properly trained and licensed operators.

P. Do not use power charge driven supports for any work that is to be hung from a horizontal surface without written permission from the Architect.

Q. Preset inserts of the proper type and holding capacity shall be used in overhead slab construction wherever possible.

R. Provide lateral supports for work to prevent excessive movement during a seismic event using rods, braces or galvanized or stainless steel cables.

S. Pendants, supports or hanging rods longer than 12 inches (300mm) shall be laterally braced.

T. Where installed in damp, wet and areas requiring wash down, all surface mounted panels, boxes, junction boxes, conduit, etc., shall be supported by spacers to provide a clearance between wall and equipment.

3.13 DISCONNECTION AND REMOVAL OF EXISTING ELECTRICAL WORK

A. The Electrical Subcontractor shall disconnect the incoming electric service, telephone, cable tv, fire alarm and all other incoming services to the buildings. The Electrical Subcontractor shall make the utility service safe for demolition work. The Electrical Subcontractor shall carefully examine the Drawings and shall visit the site to determine the extent of this work.

B. Used conduit, fittings, etc., which have been removed, shall not be reused in

conjunction with the new work unless specifically indicated otherwise on the Electrical Drawings.

3.14 FIRE STOPPING

A. Electrical installations in hollow spaces, vertical shafts and ventilation or air handling ducts shall be so made that the possible spread of fire or products of combustion will not be substantially increased. Openings around electrical penetrations through fire-resistance rated walls, partitions, floors or ceilings shall be fire stopped using approved methods to maintain the fire- resistance rating. Fire stopping of all penetrations shall be by the Electrical Contractor. The electrical contractor shall provide all required fire/smoke stopping on all corridor walls for all electrical penetrations. The electrical contractor shall provide all required firestopping and smoke stopping per code including local CITY codes.

3.15 SPECIAL COORDINATION INSTRUCTIONS

A. Coordination with the work of other trades is referred to within various parts of this SECTION. The following special instructions shall also be carefully noted:

1. The Electrical Subcontractor shall obtain from the HVAC contractor copies of all shop drawing prints showing the ductwork installation as it will be put in place on the project. These drawings shall be thoroughly checked by the Electrical Subcontractor and the routing of all conduits and installation of all outlets and electrical equipment shall be coordinated with the ductwork so as to prevent any installation conflict. Such coordination shall be done prior to roughing-in conduits, outlets and electrical equipment.

2. Locations of all wall outlets shall be verified with the Architect prior to roughing in conduits. Refer to details and wall elevations on the architectural drawings; mounting heights indicated on these architectural drawings and/or specific dimensional information given to the Electrical Subcontractor by the Architect shall take precedence over such information indicated on the electrical drawings.

3. Refer to all other drawings associated with this project. Any equipment which requires an electrical supply circuit, switch, controls and connections, even though not indicated on the electrical drawings, shall be furnished and installed as directed by the Architect. Locations of lighting fixtures shall conform to the architectural reflected ceiling plans.

4. No conduits shall be installed within any concrete slab at grade or above grade.

INSTALLATION OF OUTLETS

A. If any discrepancy is found to exist between the electrical plans and any other Drawings associated with the project, notify the Architect at once and have location verified before outlets are installed. Any reasonable change in location of outlets and equipment prior to roughing shall not involve additional expense to the Owner.

B. Consult with the ceiling tile subcontractor regarding the centering of outlets in ceiling tile. Whenever outlets of any system are installed in brick, masonry or concrete construction, furnish and install the necessary boxes and conduit in connection therewith so that the General Contractor may build them in as the work progresses. Box offsets shall be made at all outlets to provide for proper adjustment to finished surfaces.

C. Through-wall boxes will not be permitted. Outlet boxes shall not be mounted back to back, but shall be staggered a minimum of 12" on center.

D. Knockouts in any boxes shall not be left open and all boxes not having equipment mounted on them shall be provided with blank covers.

E. Bar hanger type outlets shall be used in hollow framed partitions other than those of the masonry or construction block type, with bar hanger supported from two partition studs. Bar hangers shall be secured to metal type partition studs with self- threading metal screws, or drill through hangers with caddy or approved equal clips shall be used.

3.17 PHYSICAL SEPARATION OF NORMAL, OPTIONAL STANDBY, AND EMERGENCY

A. All Article 700 and 701 emergency system generation and distribution equipment shall be installed within dedicated two-hour fire rated rooms, closets or shafts per the Electrical Code. All equipment, conduit, piping, ductwork, etc., alien to the emergency system shall not be located within these rooms, closets, or shafts except the equipment that serves these rooms, closets or shafts.

B. All Article 700 and 701 emergency equipment such as transfer switches, switchboards, transformers, and panelboards, shall be installed in two-hour fire rated rooms. The two-hour fire rated rooms shall be provided by the General Contractor.

C. All portions of the emergency system, such as feeders, located outside of rooms, closets or shafts described in paragraph B., shall also be enclosed within two-hour fire rated enclosures, provided by the Electrical Subcontractor. The Electrical Subcontractor use UL listed two-hour fire rated MI cable system for article 700 and 701 feeders outside of the two hour rated emergency electric rooms. The Electrical Subcontractor shall be responsible for sizing, routing, installation, supports, etc., of this cable in accordance with manufacturer's requirements. Submit to Designer conductor sizing calculations, voltage drop calculations, etc., for review and approval.

D. Emergency system shall be kept entirely independent of all other wiring, devices and equipment, and shall not enter the same raceways, boxes or cabinets with each other or other wiring, except in transfer switches.

3.18 UNDERGROUND CONDUIT

A. The electrical work required in conjunction with underground conduit banks shall include providing all conduits.

B. Conduits for underground banks shall be:

1. Trade diameter size as indicated but in no case less than one inch.

2. Polyvinyl chloride Schedule 40 (approved for encased burial) duct, rigid steel conduit for vertical elbows and straight sections used to penetrate equipment pads, building foundation walls and concrete slabs.

3. All conduits indicated as being incorporated into conduit banks unless specifically noted as rigid steel conduits shall be encased in a concrete envelope which accommodates the indicated configuration of conduits and which encompasses dimensions as follows:

4. Outside surfaces of conduits to outside surface of envelope where reinforcement of encasement is required - 6" minimum.

5. Outside surfaces of conduits to outside surface of envelope where no reinforcement of encasement is required - 3" minimum.

6. Spacing between centerlines of conduits assigned to different categories of use primary feeders, secondary feeders, communications and signaling - 10-1/2" minimum.

7. Spacing between centerlines of conduits assigned to the same category of use - 7-1/2" minimum.

8. Reinforcement of the concrete encasement for conduit banks where required shall consist of No. 4 longitudinal reinforcing bars located 3" in from the outside surface of the envelope and spaced 6" on centers all around. No. 8 wire reinforcing hoops set 8" apart shall be used to tie the longitudinal bars together.

9. Install conduit in such a manner as to provide a minimum cover of 30 inches:

a. Tie into existing work.
b. Pass over other underground utilities.
c. Pass over underground obstructions.
d. Assist in the avoidance of low points.

e. Increase the minimum cover where required by field conditions.
f. Lay conduit to avoid low points during run. Pitch at a minimum of three inches per 100 feet away from building.

H. Provide reinforcement for the concrete encasement of a conduit bank where:

1. It passes under or over other underground utilities.

2. It passes under or over underground obstructions.

3. Its cover is reduced to less than 30 inches.

4. It runs through foundation walls and other building construction.

I. Concrete encasement reinforcing shall extend in each case five feet beyond the points at which the determining conditions terminate.

J. Bends in conduit shall have minimum radii as follows:

1. For primary feeder 15'-0" except where specifically indicated otherwise or where turning up at termination point.

2. For primary feeder turning up at termination point - 4'-0".

K. Install conduit so that adjacent joints are staggered at least six inches from one another.

L. Offsets to accommodate field conditions shall be accomplished with two bends of not more than ten degrees each.

M. Plug both ends of all conduit stubs.

N. Seal the end of each conduit run terminating inside a building utilizing a water and gas-tight sealant manufactured specifically for the purpose.

O. After conduit has been installed with concrete encasement completed, clear each conduit of all obstructions and foreign matter by pulling a flexible mandrel (12" minimum length and a diameter 1/4" less than that of the conduit) and brush through it. In the event that obstructions are encountered in any conduit which will not permit the mandrel to pass, remove and replace the blocked section. Include in the electric work all excavation, backfilling, repair of concrete encasement and restoration of surface at grade involved in the conduit replacement.

P. Provide a nylon cord for the pulling of cable in each conduit in which no cable is to be installed as part of the electric work.

Q. The Electrical Sub-Contractor shall provide all insulated racks as required for

proper support of all cables and wires.

R. Provide a continuous nylon warning tape above each full length of duct bank 12 inches below grade.

3.19 IDENTIFICATION AND TAGGING

A. Identify individually:

1. Each transformer.

2. Each panelboard.

3. Each switch and circuit breaker.

4. Each feeder, wire or cable of all systems.

5. Each switchboard.

6. Each end of nylon pull wire in empty conduit.

B. Each wire or cable in a feeder shall be identified at its terminal points of connection and in each pullbox, junction box and panel gutter through which it passes.

C. The nomenclature used to identify panelboards or load center shall designate the numbers assigned to them, also include voltage, where power source emanates from and “normal’ or “emergency”.

D. The nomenclature used to identify switches or circuit breakers shall:

1. Where they disconnect mains or services designate this fact.

2. Where they control feeders, designate the feeder number and the name of the load supplied.

3. Where they control lighting and appliance branch circuitry, designate the name of the space and the load supplied.

E. The nomenclature used to identify feeder wires and cables shall designate the feeder number.

F. Identification for panelboards or load centers shall be by means of engraved lamacoid nameplates showing 1/4" high white lettering on a black background fastened to the outside face of the front.

G. Identification for switches or circuit breakers shall be by means of the following:

1. Where individually enclosed -- engraved lamacoid nameplates showing 1/8" high white lettering on a black background fastened on the outside front face of the enclosure.

2. Where in panelboards or load centers without doors -- same as for individually enclosed.

3. Where in panelboards or load centers with doors -- typewritten directories mounted behind transparent plastic covers, in metal frames fastened on the inside face of the doors.

H. Identification for wires and cables shall be by means of wrap around "brady" type labels.

I. Device plates for local toggle switches, toggle switch type motor starters, pilot lights and the like, whose function is not readily apparent shall be engraved with 1/8" high letters suitably describing the equipment controlled or indicated.

J. Phase identification letters shall be stamped into the metal of the bus bars of each phase of the main busses of each switchboard and each panelboard. The letters shall be visible from at least one "normal posture" location without having to demount any current carrying or supporting elements.

K. Equip the front face of all switchboard pull boxes junction boxes and the like containing cables, busing or devices operating in excess of 600 volts with enameled sheet metal "red on white" signs reading "DANGER--HIGH VOLTAGE."

L. Provide a sign at the service entrance equipment room indicating the type and location of all on site emergency or standby power sources.

M. Identify each outlet box, junction box, and cabinet used in conjunction with empty raceway for wires of a future system by means of indelible markings on the inside denoting the system.

N. Prior to installing identifying tags and nameplates, submit their nomenclature for approval. Conform to all revisions issued by the Designer.

3.20 SUPPORTS AND FASTENINGS

A. Support work in accordance with best industry standards, Mass. Electric Code and the following:

B. Include supporting frames or racks for equipment, intended for vertical surface mounting, which is required in a free standing position.

C. Supporting frames or racks shall be of standard angle, standard channel or specialty support system steel members. They shall be rigidly bolted or welded

together and adequately braced to form a substantial structure. Racks shall be of ample size to assure a workmanlike arrangement of all equipment mounted on them.

D. No work intended for exposed installation shall be mounted directly on any building surface. In such locations, flat bar members or spacers shall be used to create a minimum of 1/4" air space between the building surfaces and the work. Provide 3/4" thick exterior grade plywood painted with two coats of fire-retardant grey paint for mounting of panelboards.

E. Nothing (including outlet, pull and junction boxes and fittings) shall depend on electric conduits, raceways or cables for support.

F. Nothing shall rest on, or depend for support on, suspended ceiling media.

G. Support less than 2" trade size, vertically run, conduits at intervals no greater than 8 Ft. Support such conduits, 2-1/2" trade size or larger, at intervals no greater than the story height, or 15 Ft, whichever is smaller.

H. Where they are not embedded in concrete, support less than 1" trade size, horizontally run, conduits at intervals no greater than 7 ft.. Support such conduits, 1" trade size or larger, at intervals no greater than 10 ft.

I. Support all lighting fixtures directly from structural slab, deck or framing member.

J. Where fixtures and ceilings are such as to require fixture support from ceiling openings frames, include in the electric work the members necessary to tie back the ceiling opening frames to ceiling suspension members or slabs so as to provide actual support for the fixtures noted above.

K. Fasten electric work to building structure in accordance with the best industry practice.

L. Floor mounted equipment shall not be held in place solely by its own dead weight. Include floor anchor fastenings in all cases.

M. For items which are shown as being ceiling mounted at locations where fastenings to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to building structural elements.

N. As a minimum procedure, where weight applied to the attachment points is 100 lbs. or less, fasten to concrete and solid masonry with bolts and expansion shields.

O. As a minimum procedure, where weight applied to building attachment points exceeds 100 lbs., but is 300 lbs. or less, conform to the following:

P. At field poured concrete slabs, utilize inserts with 20' minimum length slip-through steel rods, set transverse to reinforcing steel.

3.21 SPLICING AND TERMINATING WIRES AND CABLES

A. Maintain all splices and joints in removable cover boxes or cabinets where they may be easily inspected.

B. Locate each completed conductor splice or joint in the outlet box, junction box, or pull box containing it, so that it is accessible from the removal cover side of the box.

C. Join solid conductors No. 8 AWG and smaller by securely twisting them together and soldering, or by using insulated coiled steel spring "wire nut" type connectors. Exclude "wire nuts" employing non-expandable springs. Terminate conductors No. 8 AWG and smaller by means of a neat and fast holding application of the conductors directly to the binding screws or terminals of the equipment or devices to be connected.

D. Join, tap and terminate stranded conductors No. 6 AWG and larger by means of solder sleeves, taps; and lugs with applied solder or by means of bolted saddle type or pressure indent type connectors, taps and lugs. Exclude connectors and lugs of the types which apply set screws directly to conductors. Where equipment or devices are equipped with set screw type terminals which are impossible to change, replace the factory supplied set screws with a type having a ball bearing tip. Apply pressure indent type connectors, taps and lugs utilizing tools manufactured specifically for the purpose and having features preventing their release until the full pressure has been exerted on the lug or connector.

E. Except where wire nuts are used, build up insulation over conductor joints to a value, equal both in thickness and dielectric strength, to that of the factory applied conductor insulation. Insulation of conductor taps and joints shall be by means of half-lapped layers of rubber tape, with an outer layer of friction tape; by means of half-lapped layers of approved plastic electric insulating tape; or by means of split insulating casings manufactured specifically to insulate the particular connector and conductor, and fastened with stainless steel or non-metallic snaps or clips.

F. Exclude splicing procedures for neutral conductors in lighting and appliance branch circuitry which utilize device terminals as the splicing points.

G. Exclude joints or terminations utilizing solder in any conductors used for grounding or bonding purposes.

H. Exclude all but solder or pressure indent type joints in conductors used for signaling or communications purposes.

I. Lugs for conductors used to make phase leg connections on the line side of the

main service overcurrent and switching device shall be of the limiter type.

3.22 PULLING WIRES INTO CONDUITS AND RACEWAYS

A. Delay pulling wires or cables in until the project has progressed to a point when general construction procedures are not liable to injure wires and cables, and when moisture is excluded from raceways.

B. Utilize nylon snakes or metallic fish tapes with ball type heads to set up for pulling. In raceways 2" trade size and larger, utilize a pulling assembly ahead of wires consisting of a suitable brush followed by an 3-1/2" diameter ball mandrel.

C. Leave sufficient slack on all runs of wire and cable to permit the secure connection of devices and equipment.

D. Include circular wedge-type cable supports for wires and cables at the top of any vertical raceway longer than 20 feet. Also include additional supports spaced at intervals which are no greater than 10'. Supports shall be located in accessible pull boxes. Supports shall be of a nondeteriorating insulating material manufactured specifically for the purpose.

E. Pulling lubricants shall be used. They shall be products manufactured specifically for the purpose.

F. Slack on wires and cables located in cabinets and pull boxes shall be formed and set in place in groupings corresponding to their occupancy of raceways. They shall also be arranged, with insulators and supports provided where necessary, such that cable shims or other such temporary expedients do not have to be left permanently in place to prevent the wires and cables from shifting when covers or trims are removed.

3.23 REQUIREMENTS FOR THE INSTALLATION OF JUNCTION BOXES, OUTLET BOXES AND PULL BOXES

A. Flush wall mounted outlet boxes shall not be set back to back but shall be offset at least 12" horizontally regardless of any indication on the drawings.

B. Locate all boxes so that their removable covers are accessible without necessitating the removal of parts of permanent building structure, including piping, ductwork, and other permanent mechanical elements.

C. In conjunction with concealed circuitry, abide by one of the following instructions (as may be applicable to the conditions) in order to assure the aforementioned accessibility. (Not required for circuitry concealed by removable suspended ceiling tiles.)

1. For a small (outlet size) box on circuitry concealed in a partition or wall, locate box or fitting so that its removable cover side (or the face of any

applied raised cover) penetrates through to within 1/8" a of the exposed surface of the building materials concealing the circuitry and apply a blank or device plate to suit the functional requirements.

2. For a large box on circuitry concealed in a partition, suspended ceiling, or wall, locate box totally hidden but with its removable cover directly behind an architectural access door or panel (included for the purpose, separate from the electric work) in the building construction which conceals the circuitry.

3. For a small (outlet size) box on circuitry concealed above and intended as an outlet for a surface mounted lighting fixture or other such electrical item, locate box so that its removable cover side penetrates through to the exposed surface of the building materials concealing the circuitry. Arrange the mounting of the lighting fixture or other item so that it completely covers the opening in the building construction caused by the box.

4. For a small (outlet size) box on circuitry concealed in a suspended ceiling, and intended as an outlet for a non-demountable type of recessed lighting fixtures or other such electrical items, locate box totally hidden but with its removable cover not more than one foot away from the building construction opening occupied by the demountable items.

D. Apply junction and pull boxes in accordance with the following:

1. Include pull boxes in long straight runs of raceway to assure that cables are not damaged when they are pulled in.

2. Include junction and pull boxes to assure a neat and workmanlike installation of raceways.

3. Include junction and pull boxes to fulfill requirements pertaining to the limitations to the number of bends permitted in raceway between cable access points, the accessibility of cable joints and splices, and the application of cable supports.

4. Include all required junction and pull boxes regardless of indications on the drawings (which, due to symbolic methods of notation, may omit to show some of them).

E. Apply outlet boxes in accordance with the following:

1. Unless noted below or otherwise specifically indicated, include a separate outlet box for each individual wiring device, lighting fixture and signal or communication system outlet component. Outlet boxes supplied attached to lighting fixtures shall not be used as replacements for the boxes specified herein.

2. A continuous row of fixtures of the end-to-end channel type, designed for "through wiring," and wired in accordance with the specification hereinafter pertaining to circuitry through a series of lighting fixtures, may be supplied through a single outlet box.

3. A series of separate fixtures, designed for "through wiring," spaced not more than 4' apart, and inter- connected with conduit or raceway and circuitry which is in accordance with the specifications hereinafter pertaining to circuitry through a series of lighting fixtures, may be supplied through a single outlet box.

4. Connection to recessed ceiling fixtures supplied with pigtails may be arranged so that more than one, but not more than four, such fixtures are connected into a single outlet box. When adopting this procedure:

A. Utilize an outlet box no smaller than 5" square by 2-1/2" deep.

B. Allow no fixture to be supplied from an outlet box in another room.

1. Multiple local switches indicated at a single location shall be gang mounted in a single outlet box.

2. Include all required outlet boxes regardless of indications on the drawings (which due to symbolic methods of notation, may omit to show some of them).

B. Install junction boxes, pull boxes and outlet boxes in accordance with the following:

1. Exclude surface mounted outlet boxes in conjunction with concealed circuitry.

2. Exclude unused circuitry openings in junction and pull boxes. In larger boxes each such opening shall be closed with a galvanized sheet steel plate fastened with a continuous weld all around. In small outlet type boxes, utilize plugs as specified for such boxes.

3. Close up all unused circuitry openings in outlet boxes. Unused openings in cast boxes shall be closed with approved cast metal threaded plugs. Unused openings in sheet metal boxes shall be closed with sheet metal knock-out plugs.

4. Outlet boxes for switches shall be located at the strike side of doors. Indicated door swings are subject to field change. Outlet boxes shall be located on the basis of final door swing arrangements.

5. Boxes and plaster covers for duplex receptacles shall be arranged for

vertical mounting of the receptacle.

6. Equip outlet boxes used for devices which are connected to wires of systems supplied by more than one set of voltage characteristics with barriers to separate the different systems.

C. Barriers in junction and pull boxes of outlet size shall be of the same metal as the box.

D. Barriers in junction and pull boxes which are larger than outlet size shall be of the polyester resin fiberglass of adequate thickness for mechanical strength, but in no case less than 1/4" thick. Each barrier shall be mounted, without fastenings, between angle iron guides so that they may be readily removed.

3.24 LOCATING AND ROUTING OF CIRCUITRY

A. In general, all circuitry shall be run concealed except that it shall be run exposed where the following conditions occur:

1. Horizontally at the ceiling of permanently unfinished spaces which are not assigned to mechanical or electrical equipment.

2. Horizontally and vertically in mechanical equipment spaces.

3. Horizontally and vertically in electric equipment rooms.

B. Concealed circuitry shall be so located that building construction materials can be applied over its thickest elements without being subject to spalling or cracking.

C. All circuitry and raceways shall NOT be run within any concrete slabs.

D. Circuitry run exposed shall be routed parallel to building walls and column lines.

E. Circuitry for miscellaneous systems indicated without notation as to location and routing shall be run as per the requirements and notations governing the adjacent light and power circuitry.

F. Exposed circuitry located overhead shall be run in a completely accessible manner on the underside of all piping and ductwork.

G. Circuitry run in suspended ceilings shall be routed parallel to building walls, column lines, etc.

H. Circuitry shall be routed so as to prevent electric conductors from being subject to high ambient temperature. Minimum clearances from heated lines or surfaces shall be maintained as follows:

1. Crossing where uninsulated 3"

2.	Crossing where insulated	1"
3.	Running parallel where uninsulated	36"
4.	Running parallel where insulated	6"

I. Circuitry shall not be run in elevator shafts, hoistways, and the like. Where outlets for trail cables, pit lights, run be level lights, and the like, are involved, only the "final connection" outlet boxes themselves shall be located within or open into, the confines of the shaft.

3.25 COMMISSIONING

A. Pre-function Check List

1. Pre-functional checklists assist in the process to document that the equipment and systems are installed properly.

2. The contractor will be provided with construction checklists from the CA for completion. The contractor shall complete the checklists as provide the CA with completed copies in accordance with Section 019113 Commissioning.

B. FUNCTIONAL PERFORMANCE TESTING

1. Intent of functional performance testing is to prove thru functional test procedures proper system operation.

2. The contractor will be provided with functional performance test procedures to perform while CA witnesses. The contractor shall perform functional tests in accordance with 019113 Commissioning.

C. PREFUNCTIONAL CHECKLISTS AND FUNCTIONAL PREFORMANCE TESTING

1. Pre-Functional Checklists and Functional performance testing procedures will be performed on the following system types. (Pre Functional and Functional performance testing requirements are in addition to and do not replace any testing required elsewhere in section 260001 or by applicable codes.) Equipment specifically marked as such below shall be provided with start-up of equipment by factory-authorized service representative.

a. Emergency Generator and associated transfer panels
b. Electrical Service and Switchgear, Transformers, Motor Control Centers, Distribution Systems, Low Voltage Systems, Grounding and Bonding Systems
c. Lighting and Lighting Control Systems
d. Fire Alarm system modifications

Functional Test Example

1. Submittal / Approvals

Submittal. The above equipment and systems integral to them are complete and ready for functional testing. A Statement of Correction will be submitted upon completion of any outstanding areas.

2. Prerequisite Checklist

a. All associated equipment has been started up, is operational and is ready for functional testing.
b. All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules with debugging, loop tuning and sensor calibrations completed.
c. All A/E punchlist items for this equipment corrected.
d. Safeties and operating ranges reviewed.
e. Schedules and setpoints attached.
f. This checklist does not take the place of the manufacturer's recommended checkout and startup procedures.
g. Items that do not apply shall be noted with the reasons on this form (N/A = not applicable, BO = by others).
h. Contractors assigned responsibility for sections of the checklist shall be responsible to see that checklist items by their subcontractors are completed and checked off.

3. Installation Checks

Check if Okay. Enter comment or note number if deficient.

Check **Equip Tag➔**	Lighting	Comments
Lighting		
Devices installed per manufacturer's instructions and specifications		
Lighting control system installed per plans, specifications and manufacturer's recommendations		
Switches and occupancy sensors installed at correct height and have correct cover / escutcheon plate		

The checklist items of Part 3 are all successfully completed for given trade ☐ ***YES*** ☐ ***NO***

4. Operational Checks

Check if Okay. Enter comment or note number if deficient.

Check Equip Tag➔	Lighting	Comments
Operational		
Lights are all functioning. No LED'sare malfunctioning		
Lights are not turning on and off frequently causing a disruptions		

The checklist items of Part 4 are all successfully completed for given trade ☐ YES ☐ NO

5. Functional Testing Record

Lighting Systems

Test#	**Mode ID**	**Test Procedure**	**Expected Response**	**Pass Y/N**	**Note**
1	Interior Lighting – Occupancy Sensors	With the room unoccupied and the lights off, enter the space	The occupancy sensor shall see you and the lights shall energize on. While in the space, the lights shall not continually turn off and on.		
2	Exterior Lights On	Engage the time clock/photocell functinon to simulate a need for the exterior lighting. Cover the Photocell to simulate darkness and override the time clock to simulate a suitable time to be on	All exterior lights should energize on including wall packs		
3	Exterior Lights Off	Set the time clock back to normal schedules and remove the covering from the photocell	All exterior lights should turn off including wall packs, etc.		

The Functional Tests of Part 5 have all passed for given trade ☐ YES ☐ NO

END OF SECTION

SECTION 33 11 16 – SITE WATER

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawing and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Local Utility Provider Requirements

C. FM Global Property Loss Prevention requirements including FM Data Sheet 3-10.

1.2 SCOPE OF WORK

A. Work under this Section shall consist of providing all labor, plant facilities, materials, and equipment necessary and required to install all proposed water facilities in accordance with the Contract Documents. This Work shall include but not be limited to:

1. Installation of water mains consisting of pipes, valves, thrust blocks, hydrants, and all necessary and required accessory items and operations.

B. Coordination of the connection of building fire service lines to the on-site water mains with the Building Contractor.

C. Sterilization and testing of new water facilities.

1.3 SUBMITTALS

A. Product Data: Provide manufacturer's certificate for castings, pipe and accessories to certify that products meet or exceed specified requirements.

B. Shop drawings of hydrants, valves, and valve boxes.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Ductile Iron Pipe: AWWA C151-91. Thickness Class 52 or better. Push-on joint complying with AWWA C110-90 or C153, rubber gaskets. Cement mortar lining complying with AWWA C104-90 for pipe and fittings minimum 1/16” thick. Note this type of pipe is most preferred and must be used for all lines 4” in diameter or greater.

B. Control Valves:

1. General: Provide valves and flow control devices as indicated.

2. Minimum Working Pressure: 200 psi unless otherwise indicated, or required.

3. Valves shall open left.

4. Gate Valves: Standard shut-off valves with maximum working pressure cast into body, outside-screw-and-yoke type complying with AWWA C500.

5. Check Valves: Gravity-operated, regular type, iron-bodied, bronze fitted with metal-to-metal rubber faced checks, complying with AWWA C506.

6. Butterfly Valves: Rubber seated, equipped with gear or traveling nut actuator to minimize water hammer, complying with AWWA C504.

C. Valve Boxes: Minimum 5-1/4" diameter cast iron, slide type. Covers shall be non-locking and have the word WATER in the casting.

D. Accessories:

1. General: Provide anchorages for tees, plugs, caps, and bends. After installation, apply a full coat of asphalt or other acceptable corrosion-retarding material to surfaces of rods and clamps.

2. Clamps, Straps and Washers: Steel, ANSI/ASTM A506.

3. Rods: Steel, ANSI/ASTM A575.

4. Rod Couplings: Malleable iron, ANSI/ASTM A197.

5. Bolts: Steel, ANSI/ASTM A307.

6. Cast-Iron Washers: ANSI/ASTM A126, Class A.

7. Trust Blocks: 2,500 psi concrete. Use at all changes in directions and elsewhere as necessary.

8. Fittings: Fitting should be short body, cast iron or ductile iron, and should conform and be installed per applicable AWWA C110/A21.10-82 or C153/A21.53-84.

9. Water Service Identification: Blue metallic tape reading 'WATER LINE BURIED

E. Joints:

1. Restrained: Mechanical joint restraint or field lock gaskets

2. Retaining Glands: Minimum working pressure of 250 psi

F. Hydrants:

1. Per drawings and local requirements.

2. 3-way hydrant with a 5-1/4" valve and mechanical joint connections in accordance with AWWA C502, open left as approved by the local fire marshal.

G. Concrete: Concrete for valve seats shall have a minimum compressive strength of 3,000 psi in 28 days.

H. Liquid Chlorine: In conformance with AWWA standards

I. Hypochlorite: In conformance with AWWA standards.

PART 3 - EXECUTION

3.1 GENERAL

The Contractor shall install all water pipe in the locations as shown on the Drawings and/or as approved by the Owner's Engineer. Pipe shall be of the type and sizes specified and shall be laid accurately to line and grade. Structures shall be accurately located and properly oriented. Installation should conform with applicable utility provider, AWWA and FM Global standards for the installation of water mains.

3.2 EXCAVATION AND BACKFILL

A. The bottom of the trench shall provide a minimum of 4-1/2’ of cover over the crown of the pipe. Stones are not permitted at the bottom of the trench or in contact with the pipe in any location.

B. Sand bedding shall be installed to line and grade as shown on the Contract Drawings. Bedding shall provide continuous and uniform support along the entire length of the pipe.

C. Metallic tape reading ‘WATER LINE BURIED BELOW’ shall be placed in trench along entire length of water line.

D. The trench shall be kept free of water throughout pipe installation.

E. Contractor shall plug open ends of pipe overnight with an inflatable rubber plug.

3.3 STORAGE AND HANDLING OF PIPE

All pipes shall be protected against impact, shock and free fall, and only equipment of sufficient capacity and proper design shall be used in the handling of the pipe. Storage of pipe on the job shall be in accordance with the pipe manufacturer's recommendations, subject to the approval of the Owner's Representative.

3.4 DAMAGE TO PIPE

A. Pipe which is defective from any cause, including damage caused by handling, and determined by the Owner's Representative as unrepairable, shall be unacceptable for installation and shall be replaced at no cost to the Owner as directed by the Owner's Representative.

B. Pipe that is damaged or disturbed through any cause prior to acceptance of the Work shall be repaired, realigned or replaced as directed by the Owner's Representative, at the Contractor's expense.

3.5 PIPE INSTALLATION

A. The installation of water pipe shall conform to the requirements of the utility provider, AWWA and FM Global standards and shall be laid to required lines and grades.

B. Laying Pipe - Each length of pipe shall be laid with firm, full and even bearing throughout its entire length, in a trench prepared and maintained in accordance with Section 31 08 00. All pipe shall have sufficient cover above the top of the pipe, and must be laid in separate trenches at least ten feet from the sewer pipe. Crossing of other facilities must have 12 inch minimum clearance (18 inches minimum clearance from sanitary).

C. Every length of pipe shall be inspected and cleaned of all dirt and debris before being laid. The interior of the pipe and the jointing seal shall be free from sand, dirt and trash before installing in the line. No pipe is to be trimmed or chipped to fit.

D. No length of pipe shall be laid until the preceding lengths of pipe have been thoroughly embedded in place, so as to prevent movement or disturbance of the pipe.

E. Full Length of Pipe - Full lengths of pipe are to be used whenever possible to minimize the amount of cutting and splicing in the field.

F. Bedding and Backfilling - The type of materials to be used in bedding and backfilling and the method of placement shall conform to the requirements of Section 31 08 00, Part 3.2 above, and as shown on the Details on the Drawings.

G. Protection During Construction - The Contractor shall protect the installation at all times during construction, and movement of construction equipment, vehicles and loads over and adjacent to any pipe shall be performed at the Contractor's risk.

H. At all times when pipe laying is not in progress, all open ends of pipes shall be closed by temporary watertight plugs. If water is in the trench when work is resumed, the plug shall not be removed until the trench has been pumped dry and all danger of water entering the pipe has passed.

3.6 PIPE JOINTS

A. All joints are to be made water-tight and shall be tested in accordance with the requirements of the utility provider.

B. Pipe shall be jointed in strict accordance with the pipe manufacturer's instruction. Jointing of all pipe shall be done entirely in the trench.

C. At all joints, tees, bends, dead ends and hydrants joint restraint shall be provided.

D. Install retaining glands at all mechanical joint locations per manufacturer’s installation method.

3.7 THRUST BLOCKS

Thrust blocks shall be constructed at all bends by placing a minimum of one-third cubic yard of concrete for each fitting at the undisturbed side of excavation. The thrust block construction shall be adequate to sustain the imposed load. Placement of thrust blocks shall conform to the details and schedule of the Drawings.

3.8 CONNECTION TO EXISTING FACILITIES

A. General - The Contractor shall make all required connections of the proposed water lines into existing water facilities, where and as shown on the Drawings and/or as approved by the Owner's Engineer. Connections shall be performed by a Contractor approved by the local utility provider. The Contractor shall perform any investigation measures including, but not limited to, exploratory test pits to confirm the point of tie-in and avoidance of other utilities. All investigation measures should be performed a minimum of two weeks prior to the start of water main installation work. Notify Engineer of any conflicts. The Contractor shall be responsible for relocating utilities in conflict.

B. Compliance with Requirements of Owner of Facility - Connections into existing water facilities shall be performed in accordance with the requirements of the Owner of the facility. The Contractor shall be required to comply with all such requirements, including securing of all required permits, and paying the costs thereof. The cost of making the connections in accordance with the requirements of the owner of the existing facility shall be included in the Contract Sum.

C. Owner’s written approval is required for any interruptions to existing utility services. Provide two weeks notice of any proposed interruptions.

3.9 SERVICE LINES

A. General - The Contractor shall terminate the water laterals five feet from the building. Work shall include making the service line connections into the on-site water mains, furnishing and installing all service line pipe from the on-site water main systems to points located five feet outside of the proposed building lines and properly sealing the ends with watertight plugs. Service line extensions from these points into the building will be performed by the Building Contractor.

B. Coordination with Building Contractor - The Contractor shall be required to coordinate his work with the work of the Building Contractor to determine the exact location and elevation of the point of entry into the building. If the Building Contractor has installed his portion of the water service line, work under this Contract shall also include final connection of the water service line five feet outside the building line to the building service line at no additional cost to the Owner. The Contractor shall review the latest architectural/ mechanical plans to verify the location of the service laterals.

3.10 STERILIZING

A. All new water lines shall be flushed, sterilized and inspected prior to being put into service and the final connection(s) made to the existing system. Contractor shall sterilize lines in accordance with AWWA C601 or the local utility requirements, whichever is more restrictive.

B. The contractor is responsible for properly disposing of any chlorinated water in accordance with all State and Federal regulations. Any required permits for this work is also the responsibility of the contractor.

3.11 TESTING

A. General: The Contractor shall coordinate and perform all required testing in connection with water line installation. Hydrostatic and leakage tests shall be performed in accordance with the latest edition of AWWA C600, FM Global standards or the local utility requirements, whichever is most restrictive.

B. Scheduling of pressure and leakage tests shall be coordinated with the local water company and performed in the presence of local water company personnel.

C. Contractor shall furnish all necessary items to complete the required tests. Items include, but are not limited to:

1. Temporary plugs or caps
2. Pumps
3. Water meter
4. Pressure guage

D. Pipes proposed to be encased in concrete shall be tested prior to placing of the concrete.

3.12 FINAL INSPECTION

Upon completion of the Work and before final acceptance by the Owner, the entire water system may be subjected to a final inspection in the presence of the Owner's Engineer and the utility provider. The Work shall not be considered as complete until all requirements for line, grade, cleanliness, leakage tests and workmanship have been met.

END OF SECTION 33 11 16

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APPENDIX A

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CONSTRUCTION SAFETY AND PHASING PLAN NARRATIVE

This Construction Safety and Phasing Plan (CSPP) Narrative is for the Aircraft Rescue and Firefighting (ARFF) Facility Renovations Project at the Tweed-New Haven Airport in New Haven, Connecticut. The purpose of the project is to construct an additional bay for a second ARFF vehicle and to provide utility services for the new bay and the existing building.

1. **COORDINATION.** This section includes descriptions of design coordination efforts to date and proposed efforts during construction.

   a) Scoping and Predesign Meeting: A Scoping and Predesign meeting was held. Attending this meeting were representatives from the Airport and Langan. During this meeting the general project description, planning and impacts were discussed as follows:

   - Engineer's Contract
   - Planning Considerations
   - Design Parameters
   - Document Deadlines

   b) Construction Safety Phasing Plan (CSPP): A Construction Safety Phasing Plan (CSPP) was discussed with representatives from the Airport and Langan. Specific operational requirements, impacts and mitigation measures were discussed as follows:

   - Anticipated Construction Season
   - Construction Duration
   - Construction Impacts and Operational changes
   - Phasing
   - Haul routes, stockpile areas, and staging areas for contractor use.

   c) Pre-Bid Meeting: The CSPP will be reviewed in general with potential bidders during the pre-bid meeting.

   d) Pre-Construction Conference: The CSPP will be reviewed with the contractor in detail at the pre-construction conference for the project. The contractor will be reminded to prepare and submit the required Safety Plan Compliance Document (SPCD) prior to beginning construction.

   e) Contractor Progress Meetings: Progress construction meetings will be held during the duration of the construction activities. The CSPP and SPCD will be standing agenda items for these meetings. Daily coordination with the Airport Operations Manager will be mandatory and include a morning briefing of the proposed work for the day with an anticipated end time.

   f) Scope or Schedule Changes: Changes in the scope or duration of the project will include a review of the Construction Safety Phasing Plan (CSPP). This review may necessitate revisions to the CSPP that will require review and approval by the Airport.

g) Phase of Work: The phasing of the work will be included with the bid documents.

2. CONSTRUCTION PHASING

To enhance safety during construction and minimize the impacts on Airport operations caused by the construction, the project is shown as three (3) Phases. CSPP drawings for each phase (Sheets KT200 through KT203) can be found attached to the end of this narrative.

Phase 1: - Expansion Bay, Concrete Apron, and Utility Installations

a) Duration: Eight (8) months

b) Description: This phase includes construction of the expansion bay, construction of the concrete apron south of the bay, and various utility installations and relocations.

Operational Impacts: ARFF vehicle access from the existing bay to taxiway will be maintained at all times. Lighted barrels will be installed along the eastern edge of existing driveway. Temporary closure (2 days) of the northern overhead door will be required for utility work. This will not impact ARFF vehicle access to the taxiway. Personnel access to the ARFF building will be maintained at all times. Work schedule will be coordinated with the Airport.

c) Work Areas: This work area includes Phase 1 shown on sheet KT201.

Phase 2: - Utility Installations and Driveway Connection to Taxiway

a) Duration: Five (5) Consecutive workdays (Mon – Fri)

b) Description: This phase includes installation of fire water piping crossing under the driveway, relocating an electrical hand hole and encasing conduit crossing under the driveway, backfilling and compaction, and construction of the asphalt driveway connecting the new bay to the taxiway. Work will occur within the taxiway safety area and require temporary closure of the taxiway. Work schedule will be coordinated with the the Airport.

c) Operational Impacts: Airport to temporarily relocate ARFF vehicle outside of the project area. Temporary closure (5 days) required of Taxiway C from Taxiway B to intersection with Taxiway A and Taxiway B from Taxiway C to intersection with Taxiway E. Low profile construction barricades will be utilized. Openings in the barricades will be provided to maintain ARFF vehicle access.

d) Work Areas: This work area includes Phase 2 shown on sheets KT200 and KT202.

Phase 3: - Utility Installations

a) Duration: One (1) month

b) Description: This phase includes installation of fire water piping, utilities and mechanical equipment on the west side of the ARFF building.

c) Operational Impacts: ARFF vehicle access from the existing bay to taxiway will be maintained at all times. Construction access to this area will require periodic escorted crossing of the ARFF driveway. Access gates will be provided for this purpose and managed by the Airport. Work schedule will be coordinated with the Airport.

d) Work Areas: This work area includes Phase 3 shown on sheet KT203.

3. AREAS AND OPERATIONS AFFECTED BY THE CONSTRUCTION ACTIVITY

a) The following areas will be affected during construction: Existing ARFF facility and operations as various phases outline above. Phase 2 will require closure of portions of Taxiway B and Taxiway C for 5 consecutive workdays.

b) Identification of Affected Areas: The CSPP drawings show the areas and operations affected by the construction activity.

c) Mitigation of Effects: To enhance safety and to minimize the impacts to Airport Operations:

- If the contractor wishes to have multiple crews working simultaneously in separate work areas, each work crew must be accompanied by a dedicated badged escort.
- Airport Management will coordinate the closure periods and times of affected operation areas with the Airport users to minimize the impact.
- Airport Management will coordinate with local Police and Fire officials to inform them of the project, related closures, and hazards.
- All utilities within the work area will be maintained in a fully functional state unless otherwise specified in this CSPP. Temporary drainage will be installed, as required, to maintain existing flow patterns and prevent standing water.

4. PROTECTION OF NAVIGATIONAL AIDS (NAVAIDS): There will be no impact to NAVAIDS on this project.

5. CONTRACTOR ACCESS: The following describes the locations of stockpiles, site access, escorts, airfield driving, radio communications, and other procedures:

Stockpile and Equipment Parking Locations: The material stockpile locations and the equipment parking locations are as shown on Sheets KT201 through KT203. Maximum stockpile height is 20 feet.

Site Access: The contractor will only be able to access the site through the vehicle gate as identified on Sheet CS101. Gate guard and an escort will be provided by the Airport.

Driving on the Airfield: The contractor will be required to explicitly follow the directions of the escort while driving in the Airport Operations Area (AOA). The AOA is defined as the area inside of the defined perimeter fencing surrounding the Airport. Additionally, the contractor must follow the directions of Airport Air Traffic Control Tower and any Airport personnel. All movement of vehicles, outside of designated work areas must be approved by the escort or other approved personnel.

Conclusion of Work Daily: The contractor cannot leave the site until the work area has been inspected and accepted by the Airport Operator for safety compliance.

Escorts: The Airport will provide the escort. No more than three (3) vehicles can be under the supervision of the escort. All vehicles under the supervision of the escort must be in direct visual communication with the escort. If the contractor wishes to have multiple crews working simultaneously in separate work areas, each work crew must be accompanied by an escort. The request for multiple escorts is at the Airport's discretion.

Radio Communications: The contractor's foreman and the escort will be required to monitor the tower ground radio frequency at all times during construction and will communicate directly with the ground controller for movement within the AOA which is outside of the designated work area(s).

Marking and Lighting of Vehicles: The marking and lighting of vehicles shall be in accordance with Federal Aviation Administration (FAA) Advisory Circular (AC) 150/5210-5 ("Painting, Marking, and Lighting of Vehicles Used on an Airport"). The contractor will be required to provide the following for every vehicle:

- Each vehicle/equipment must be equipped with a construction flag.
    - 3' by 3' minimum overall dimensions.
    - checked with international orange and white squares.
    - square sizes 1' minimum; and
    - corner squares shall be international orange.
- Each vehicle must be equipped with a flashing yellow beacon.
    - must be on the tallest point of the vehicle; and
    - viewable from all directions.
- Each vehicle/equipment must be equipped with a placard with the company name on both sides of the vehicle/equipment.
    - must be easily recognizable; and
    - minimum of 200 square inches.

Vehicle and Personnel Operations: No person shall enter the AOA or any other restricted area without the escort. For this project, there will be visual boundaries installed for each phase, unless otherwise directed by Airport Operations. If nighttime visual boundaries are required, they will be low-profile barricades with water ballast. The barricades will be provided by the airport. The contractor will be required to assist Airport Operations in the placement and removal of all barricades or other visual boundaries. Only vehicles essential in completing the work will be allowed access to the AOA. The contractor will maintain a daily log of all personnel entering and leaving the site. The contractor shall provide personnel to become badged by ACK.

Employee Parking Area: The contractor (including subcontractors) may only park in areas designated by the owner. The contractor will be required to provide transportation for all employees from the employee parking area to the work area. No employee cars may be parked within the AOA for any reason and at any time.

Haul Routes: The haul route for the work is Thompson Avenue to the vehicle gate shown on Sheet CS101.

Rules of Vehicle Operations: The following are the rules of operation and must be followed at all times.

- Prior to entry onto the Airfield, vehicles shall be inspected by the driver. All dirt and debris shall be removed from the tires that can be tracked into the Airfield. Each operator must possess a valid license for operation of the particular vehicle and may be required to furnish the license for access to the AOA.

- Motor vehicles must not be operated in a reckless and/or negligent manner, a manner that may endanger other people or property, and/or in excess of 15 miles per hour unless the posted speed limit is less.
- Aircraft always have the right-of-way. Vehicles and equipment shall always pass behind aircraft.
- All appropriate signaling devices must be used at all times and obey all traffic signs, markings, and lanes.
- Each operator must not be under the influence of drugs or alcohol.
- No cell phone use is allowed while operating any vehicle or equipment.
- Escorts are required to drive from one work area to another.
- All vehicles must have the required and proper license plates and inspection stickers.
- All vehicles must have working head and taillights which are required to be used from one hour prior to dusk and one hour after sunrise, as required by Airport Operations, times of low visibility, and/or during Instrument Flight Rules (IFR) conditions.

6. WILDLIFE MANAGEMENT: Wildlife hazards will be mitigated during construction as follows:

Trash: All construction personnel will dispose of food scraps in the appropriate containers provided by the contractor. The contractor will be required to keep a closable trash receptacle in the back of a truck with each crew.

Standing Water: No pools of standing water shall be created during construction that may attract wildlife. Any such standing water shall be immediately corrected by the contractor.

Wildlife Sightings: The contractor will be responsible for reporting any wildlife sightings to Airport Operations immediately. Airport Operations will immediately notify pilots and the air traffic control tower via the appropriate airfield frequency.

7. FOREIGN OBJECT DEBRIS (FOD) MANAGEMENT: FOD will be mitigated during construction as follows:

Training: The contractor shall provide training to all employees working within the AOA on effective FOD management. Training shall be documented and include information on the definition of FOD, consequences of FOD, FOD awareness, who is responsible for mitigating FOD, and housekeeping procedures.

Housekeeping: Prevention of FOD is the most effective form of FOD management. The contractor must monitor construction activities and proactively develop a plan to prevent FOD from occurring. Typical FOD prevention measures include the use of covered trash receptacles, covering of loads, zero tolerance of littering, no smoking in the AOA, unwrapping construction materials in a controlled environment, not opening both doors of equipment/vehicles at the same time, awareness of jet blast and propwash, and tying down items that can easily become windblown.

Trash: All construction personnel will dispose of food scraps, construction waste, boxes, paper, and other items in the appropriate containers provided by the contractor. The

contractor will be required to keep a closable trash receptacle in the back of a truck with each crew.

Airfield Access: The contractor will be responsible for checking and removing dirt and debris from all tires and tracks from vehicles and equipment, including equipment on flat beds prior to entering the AOA. Additionally, flat beds shall be adequately cleaned. All materials removed shall be placed in an appropriate container and disposed of by the contractor. The contractor shall have all appropriate devices to clean any FOD from the pavement including sweepers and shop vacuums.

Smoking: Smoking will not be permitted while within the AOA.

8. **HAZARDOUS MATERIALS (HAZMAT) MANAGEMENT:** HAZMAT will be mitigated during construction as follows:

Spills: The contractor is required to have adequate spill kits capable of containing and removing leaked or spilled fuels. The contractor is required to immediately contact Airport Operations regarding all spills. The contractor will be required to pay any fines (including cleaning costs) levied against the Airport for any spill caused by the contractor.

Fueling: The contractor will only be allowed to fuel vehicles in the designated Contractor Staging area, unless authorized by the Airport.

Airport Emergency Plan: In the event of an emergency event involving an aircraft the Contractor shall be required to stop work and vacate the area while following all Airport directions.

9. **NOTIFICATION OF CONSTRUCTION ACTIVITIES:** The following is the method of communication for the project. Additional contacts can be provided if needed on a separate Project Contact Sheet.

Emergency: **911**

General Contact List: The following is contact list of Airport personnel and relevant contacts:

- Airport Operations _____
- Airport Maintenance _____
- CT State Police (Troop I) 1-800-956-8818
- Local FAA Control Tower _____
- Poison Control 800-222-1222
- Resident Engineer TBD
- Contractor TBD

FAA Notification:

7460-1 forms have been submitted for the construction of this project.

Project: _____

Aeronautical Study Numbers: _____

Notice to Airmen (NOTAMs): Airport Operations will issue all NOTAMs.

Emergency Notification: In the case of a life-threatening situation, dial **911** and then contact the Airport immediately. The Airport will coordinate any emergency response as outlined in the Airport Emergency Plan (AEP).

10. INSPECTION REQUIREMENTS: The following are the inspection requirements:

Airport Requirements: Airport Operations will be responsible for inspecting all areas prior to reopening to aircraft operations as well as conducting a final inspection at the completion of the project.

Resident Engineer Requirements: The resident engineer will conduct inspections at the end of each shift or when work progresses from one location to another location. The resident engineer will contact Airport Operations to conduct inspections as noted above. The resident engineer will attend the final inspection. In the event of any emergency the resident engineer will contact Airport Operations.

Contractor Requirements: The contractor will be required to conduct routine inspections of the work areas. The contractor may not leave the site for the day until the work areas have been approved by the resident engineer.

11. UNDERGROUND UTILITIES: The contractor will be required to coordinate with Airport Operations, the Local FAA SSC, and Call-Before-You-Dig to determine if any underground cables exist in the work areas. The contractor shall make provisions to protect any cables identified by Airport Operations, the Local FAA SSC, or Call-Before-You-Dig. Any damage to cables identified by Airport Operations, the Local FAA SSC, or Call-Before-You-Dig shall be the responsibility of the contractor to repair to the requirements of the owner of the damaged utility. The contractor shall locate or hire an experienced company to locate all utilities within each of the work areas.

12. PENALTIES: The following are a list of penalties for violations while working on the project:

Construction Suspension: Airport Operations will suspend all construction if a Contractor enters the AOA without the appropriate escort and approval from the CSPP.

Expulsion of Employees: The Airport may permanently prohibit any Contractor employee acting in violation of Airport rules and regulations.

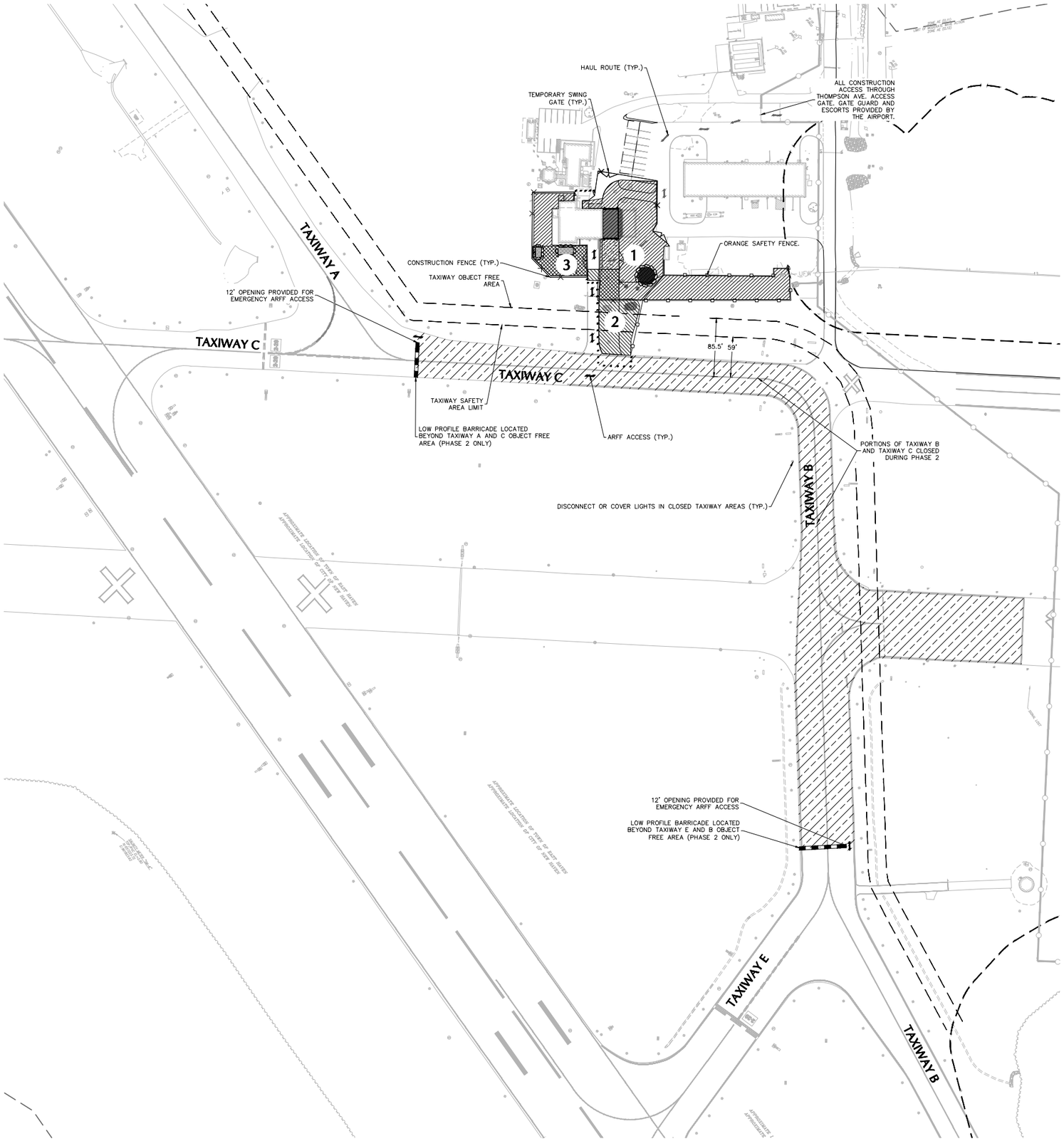
13. SPECIAL CONDITIONS: None.

14. RUNWAY AND TAXIWAY VISUAL AIDS: Low profile construction barriers will be utilized as visual aids for partial closure of taxiways.

15. MARKING AND SIGNS FOR ACCESS ROUTES: Markings or signage will be installed as needed to delineate the access routes and all movements in the AOA by the contractor will be under the supervision of the escort.

16. **HAZARD MARKING AND LIGHTING:** Vehicle marking, signage, and lighting will be as specified in Section 5.

17. **PROTECTION OF AREAS, ZONES, AND SURFACES:** No equipment will be allowed to penetrate any protected safety areas, object free zone or approach surfaces. The contractor will be required to meet any additional requirements set by the Airport.



GENERAL NOTES

1. BOUNDARY AND TOPOGRAPHIC INFORMATION WAS OBTAINED FROM A PLAN TITLED "TOPOGRAPHIC SURVEY" FOR TWEED AIRPORT ARFF FACILITY RENOVATIONS BY LANGAN. DATED APRIL 15, 2025. COORDINATES REFERENCED TO NAD83 AND NAVD88 IN COMBINATION WITH TWEED AIRPORT PRIMARY AIRPORT CONTROLS AND SECONDARY AIRPORT CONTROLS.
2. THE SITE IS LOCATED IN A COASTAL ZONE AE (SHADED), AN AREA SUBJECT TO COASTAL FLOODING WITH MODERATE WAVE ACTION PER FIRM MAP 09009C0444J, EFFECTIVE DATE JULY 8, 2013. BASE FLOOD ELEVATION IS 12' NAVD88.
3. ADDITIONAL SITE AND UTILITY INFORMATION WAS OBTAINED FROM A PLAN TITLED "SITE PLAN" FOR TWEED AIRPORT TEMPORARY SECURITY FENCE AND PARKING PREPARED BY LANGAN AND DATED 09/13/2024.

WORK AREA NOTES

PROJECT DURATION:

- ALL WORK MUST BE COMPLETED WITHIN THE 10 MONTH PROJECT DURATION.
- WORK IN PHASE 1 CONSTRUCTION AREA MAY BE CONDUCTED CONCURRENTLY WITH SUBSEQUENT PHASES
- SEE SHEETS KT201 THROUGH KT203 FOR PHASE SCOPE AND DURATIONS.

WORK ITEMS;

- INSTALL SAFETY EQUIPMENT FOR AREA CLOSURE AND MOBILIZE.
- REROUTE EXISTING COMMUNICATION UTILITIES.
- CONSTRUCT ARFF BUILDING ADDITION.
- EXTEND CULVERTS, FIREWATER SERVICE LINE, AND UTILITIES FOR ARFF BUILDING.
- FILL AND COMPACT TO ROUGH GRADE, INSTALL PAVEMENT BASE AND BITUMINOUS CONCRETE DRIVEWAYS.
- STRIPE AND SIGN EXPANDED DRIVEWAY.
- REMOVE SAFETY EQUIPMENT, TEMPORARY CONSTRUCTION FENCE, SWING GATE, AND BARRIERS.

OPERATIONAL IMPACTS:

- TAXIWAY C FROM TAXIWAY B TO INTERSECTION WITH TAXIWAY A (PHASE 2).
- TAXIWAY B FROM TAXIWAY C TO INTERSECTION WITH TAXIWAY E (PHASE 2).
- ARFF DRIVEWAY CLOSURE (PHASE 2)
- TAXIWAY B AND C WILL REMAIN OPEN TO ARFF EMERGENCY OPERATIONS.

WORK AREA VISUAL AIDS:

- LOW PROFILE CONSTRUCTION BARRICADES WITH SOLAR POWERED RED FLASHING WARNING LIGHTS FOR TAXIWAY CLOSURE.
- TEMPORARY SAFETY FENCE
- CONSTRUCTION FENCE
- ILLUMINATED TRAFFIC DRUMS

WORK HOURS:

- THE CONTRACTOR IS PERMITTED TO WORK BETWEEN 7 AM AND 5 PM UNLESS EXTENDED HOURS ARE AUTHORIZED BY THE AIRPORT.

PHASING NOTES:

1. CONTRACTOR ESCORT SHALL REMAIN WITH CONSTRUCTION CREW AT ALL TIMES.
2. CONTRACTOR SHALL COMMUNICATE WITH ESCORT PRIOR TO CROSSING ANY AREAS OPEN TO AIRCRAFT OPERATIONS.
3. DRIVEWAY AND TAXIWAY ACCESS TO THE EXISTING ARFF GARAGE BAY MUST BE MAINTAINED AT ALL TIMES EXCEPT AS SCHEDULED IN PHASE 2.
4. THOMPSON AVE. ACCESS GATE MUST REMAIN CLEAR AT ALL TIMES FOR EMERGENCY VEHICLE ACCESS.
5. OWNER SHALL PROVIDE GATE GUARD TO BE STATIONED AT THOMPSON AVE. ACCESS GATE DURING WORKING HOURS. OWNER SHALL PROVIDE ESCORT FOR COMMUNICATING WITH ARFF, ATC, AND AIRPORT GROUND OPERATIONS.
6. MAXIMUM HEIGHT OF CONSTRUCTION EQUIPMENT IS 33' ABOVE GRADE. EXCEEDING THIS REQUIRES FAA APPROVAL.

LEGEND

	EXISTING	PROPOSED
BUILDING LINE		
BITUMINOUS CONCRETE PAVEMENT		
CONCRETE PAVEMENT		
CATCH BASIN		
UTILITY MANHOLE		
FIRE HYDRANT		
CONSTRUCTION AREA PHASE 1 & 3		
CONSTRUCTION AREA PHASE 2		
TAXIWAY CLOSURE–PHASE 2 ONLY		
LOW PROFILE BARRICADE		
CONSTRUCTION FENCE		
TEMPORARY SAFETY FENCE		
ILLUMINATED TRAFFIC DRUMS		
CONTRACTOR HAUL ROUTE		
ARFF VEHICLE ACCESS ROUTE		
TEMPORARY STOCKPILE		

SCALE: 1 INCH = 75 FEET

Date	Description	No.
Revisions		

Signature Date

Christopher Cardany
PEN. 21995

LANGAN
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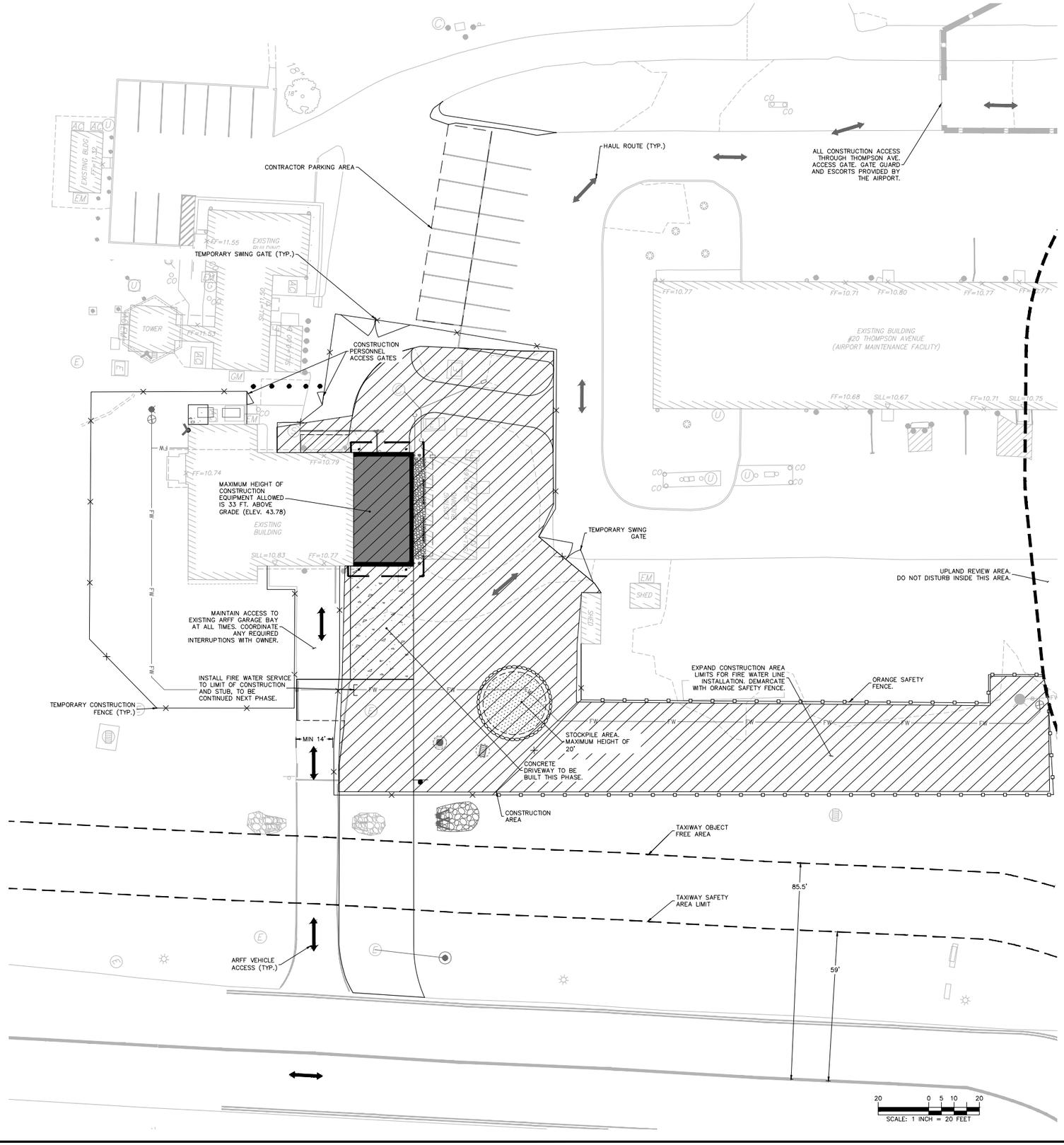
Project
TWEED-NEW HAVEN AIRPORT ARFF FACILITY RENOVATIONS
EAST HAVEN CONNECTICUT

Drawing Title
OVERALL CONSTRUCTION SAFETY AND PHASING PLAN

Project No.	Drawing No.
140318901	KT200
Date: 05/13/2025	
Drawn By: BTM	
Checked By: JDD	

LANGAN Project No. 140318901



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WORK AREA NOTES

PROJECT DURATION:

- ALL WORK MUST BE COMPLETED WITHIN THE 10 MONTH PROJECT DURATION
- WORK THIS PHASE SHOULD BE COMPLETED WITHIN 10 MONTHS.

WORK ITEMS;

- INSTALL SAFETY EQUIPMENT FOR AREA CLOSURE AND MOBILIZE
- INSTALL TEMPORARY CONSTRUCTION FENCE, SWING GATE, BARRICADES, AND ILLUMINATED TRAFFIC DRUMS FOR PHASE 1.
- REROUTE COMMUNICATIONS UTILITIES TO ELECTRIC VAULT BUILDING.
- CONSTRUCT ARFF FACILITY EXPANSION. EXPAND CONCRETE DRIVEWAY.
- INSTALL FIRE WATER SERVICE LINE UP TO EXTENTS OF EXISTING PAVEMENT.
- REMOVE BARRIERS AND LOW PROFILE BARRICADES FOR PHASE 1.

OPERATIONAL IMPACTS:

- NONE

WORK AREA VISUAL AIDS:

- CONSTRUCTION FENCE
- ILLUMINATED TRAFFIC DRUMS

WORK HOURS:

- THE CONTRACTOR IS PERMITTED TO WORK BETWEEN 7 AM AND 5 PM UNLESS EXTENDED HOURS ARE AUTHORIZED BY THE AIRPORT.

PHASING NOTES:

1. CONTRACTOR ESCORT SHALL REMAIN WITH CONSTRUCTION CREW AT ALL TIMES.
2. CONTRACTOR SHALL COMMUNICATE WITH ESCORT PRIOR TO CROSSING ANY AREAS OPEN TO AIRCRAFT OPERATIONS.
3. DRIVEWAY ACCESS TO THE EXISTING ARFF GARAGE BAY MUST BE MAINTAINED AT ALL TIMES.
4. THOMPSON AVE. ACCESS GATE MUST REMAIN CLEAR AT ALL TIMES FOR EMERGENCY VEHICLE ACCESS.
5. OWNER SHALL PROVIDE GATE GUARD TO BE STATIONED AT THOMPSON AVE. ACCESS GATE DURING WORKING HOURS. OWNER SHALL PROVIDE ESCORT FOR COMMUNICATING WITH ARFF, ATC, AND AIRPORT GROUND OPERATIONS.
6. MAXIMUM HEIGHT OF CONSTRUCTION EQUIPMENT IS 33' ABOVE GRADE.

LEGEND

	EXISTING	PROPOSED
BUILDING LINE		
BITUMINOUS CONCRETE PAVEMENT		
CONCRETE PAVEMENT		
CATCH BASIN		
UTILITY MANHOLE		
FIRE HYDRANT		
CONSTRUCTION AREA THIS PHASE		
LOW PROFILE BARRICADE		
CONSTRUCTION FENCE		
AREAS OPEN TO AIRCRAFT		
TEMPORARY SAFETY FENCE		
ILLUMINATED TRAFFIC DRUMS		
CONTRACTOR HAUL ROUTE		
ARFF VEHICLE ACCESS ROUTE		
TEMPORARY STOCKPILE		

Date	Description	No.
Revisions		

Signature Date

Christopher Cardany
PEN. 21995

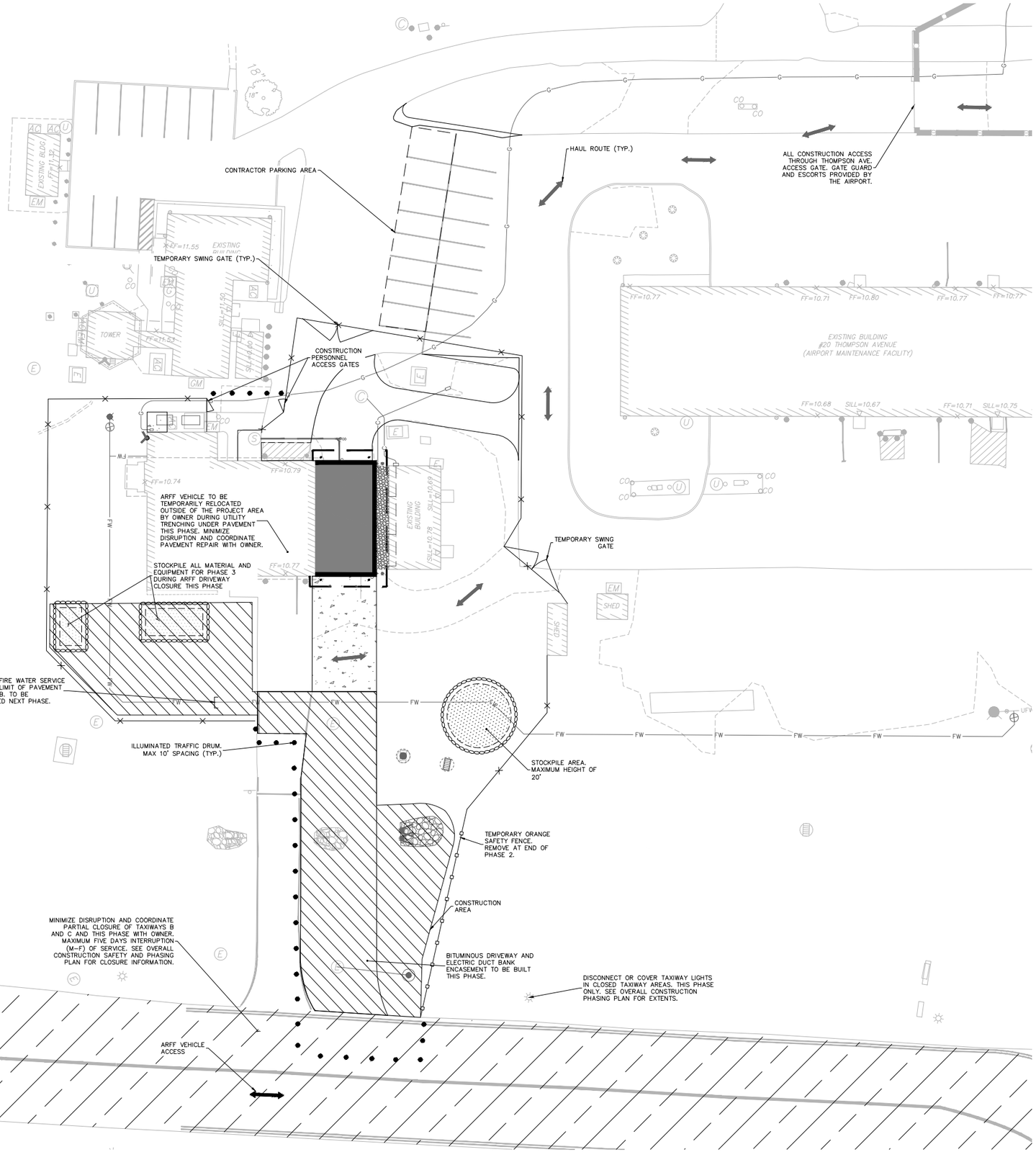
LANGAN
Langan CT, Inc.
555 Long Wharf Drive, 9th Floor
New Haven, CT 06511
T: 203.562.5771 F: 203.789.6142 www.langan.com

Project
TWEED-NEW HAVEN AIRPORT ARFF FACILITY RENOVATIONS
EAST HAVEN CONNECTICUT

Drawing Title
CONSTRUCTION SAFETY AND PHASING PLAN PHASE 1

Project No.	Drawing No.
140318901	KT201
Date: 05/13/2025	
Drawn By: BTM	
Checked By: JDD	

Project No. 140318901



GENERAL NOTES

1. BOUNDARY AND TOPOGRAPHIC INFORMATION WAS OBTAINED FROM A PLAN TITLED "TOPOGRAPHIC SURVEY" FOR TWEED AIRPORT ARFF FACILITY RENOVATIONS BY LANGAN. DATED APRIL 15, 2025. COORDINATES REFERENCED TO NAD83 AND NAVD88 IN COMBINATION WITH TWEED AIRPORT PRIMARY AIRPORT CONTROLS AND SECONDARY AIRPORT CONTROLS.
2. THE SITE IS LOCATED IN A COASTAL ZONE AE (SHADED), AN AREA SUBJECT TO COASTAL FLOODING WITH MODERATE WAVE ACTION PER FIRM MAP 09009C0444J, EFFECTIVE DATE JULY 8, 2013. BASE FLOOD ELEVATION IS 12' NAVD88.
3. ADDITIONAL SITE AND UTILITY INFORMATION WAS OBTAINED FROM A PLAN TITLED "SITE PLAN" FOR TWEED AIRPORT TEMPORARY SECURITY FENCE AND PARKING PREPARED BY LANGAN AND DATED 09/13/2024.

WORK AREA NOTES

PROJECT DURATION:

- ALL WORK MUST BE COMPLETED WITHIN THE 10 MONTH PROJECT DURATION.
- ALL WORK THIS PHASE MUST BE COMPLETED WITHIN 5 CONSECUTIVE WORKDAYS (M–F).

WORK ITEMS:

- REMOVE CONSTRUCTION FENCE FOR PHASE 1 FIRE WATER SERVICE TRENCH.
- RELOCATE ARFF VEHICLE OUTSIDE OF ARFF BUILDING.
- INSTALL CONSTRUCTION AREA BARRIERS FOR PHASE 2.
- INSTALL SAFETY EQUIPMENT FOR AREA CLOSURE AND MOBILIZE.
- INSTALL LOW PROFILE BARRICADES FOR TAXIWAY B AND C CLOSURE. DISCONNECT OR COVER TAXIWAY LIGHTS WITHIN AREA OF CLOSURE.
- EXTEND CULVERTS, FIRE WATER SERVICE LINE, AND ENCASE UTILITY CONDUITS UNDER DRIVEWAY.
- FILL AND COMPACT TO ROUGH GRADE, INSTALL PAVEMENT BASE AND BITUMINOUS CONCRETE DRIVEWAY.
- REMOVE SAFETY EQUIPMENT, TEMPORARY CONSTRUCTION FENCE, SWING GATE, AND BARRIERS.

OPERATIONAL IMPACTS:

- TAXIWAY C FROM TAXIWAY B TO INTERSECTION WITH TAXIWAY A.
- TAXIWAY B FROM TAXIWAY C TO INTERSECTION WITH TAXIWAY E.
- ARFF DRIVEWAY CLOSED THIS PHASE. ARFF VEHICLE TO BE TEMPORARILY RELOCATED.

WORK AREA VISUAL AIDS:

- LOW PROFILE CONSTRUCTION BARRICADES WITH SOLAR POWERED RED FLASHING WARNING LIGHTS FOR TAXIWAY CLOSURE.
- TEMPORARY SAFETY FENCE
- CONSTRUCTION FENCE
- ILLUMINATED TRAFFIC DRUMS

WORK HOURS:

- THE CONTRACTOR IS PERMITTED TO WORK BETWEEN 7 AM AND 5 PM UNLESS EXTENDED HOURS ARE AUTHORIZED BY THE AIRPORT.

PHASING NOTES:

1. CONTRACTOR ESCORT SHALL REMAIN WITH CONSTRUCTION CREW AT ALL TIMES.
2. CONTRACTOR SHALL COMMUNICATE WITH ESCORT PRIOR TO CROSSING ANY AREAS OPEN TO AIRCRAFT OPERATIONS.
3. ARFF VEHICLE TO BE TEMPORARILY RELOCATED THIS PHASE. ARFF ACCESS MUST BE MAINTAINED ON TAXIWAYS B AND C.
4. THOMPSON AVE. ACCESS GATE MUST REMAIN CLEAR AT ALL TIMES FOR EMERGENCY VEHICLE ACCESS.
5. OWNER SHALL PROVIDE GATE GUARD TO BE STATIONED AT THOMPSON AVE. ACCESS GATE DURING WORKING HOURS. OWNER SHALL PROVIDE ESCORT FOR COMMUNICATING WITH ARFF, ATC, AND AIRPORT GROUND OPERATIONS AND FOR ESCORTING CONSTRUCTION STAFF TO DEPLOY TAXIWAY CLOSURE BARRIERS.
6. MAXIMUM HEIGHT OF CONSTRUCTION EQUIPMENT IS 33' ABOVE GRADE.
7. SEE OVERALL CONSTRUCTION SAFETY AND PHASING PLAN FOR TAXIWAY CLOSURE INFORMATION.

LEGEND

	EXISTING	PROPOSED
BUILDING LINE		
BITUMINOUS CONCRETE PAVEMENT		
CONCRETE PAVEMENT		
CATCH BASIN		
UTILITY MANHOLE		
FIRE HYDRANT		
CONSTRUCTION AREA THIS PHASE		
TAXIWAY CLOSURE THIS PHASE		
LOW PROFILE BARRICADE		
CONSTRUCTION FENCE		
TEMPORARY SAFETY FENCE		
ILLUMINATED TRAFFIC DRUMS		
CONTRACTOR HAUL ROUTE		
AARF VEHICLE ACCESS ROUTE		
TEMPORARY STOCKPILE		

20 0 5 10 20
SCALE: 1 INCH = 20 FEET

Date	Description	No.
Revisions		

Signature Date
Christopher Cardany
PEN. 21995

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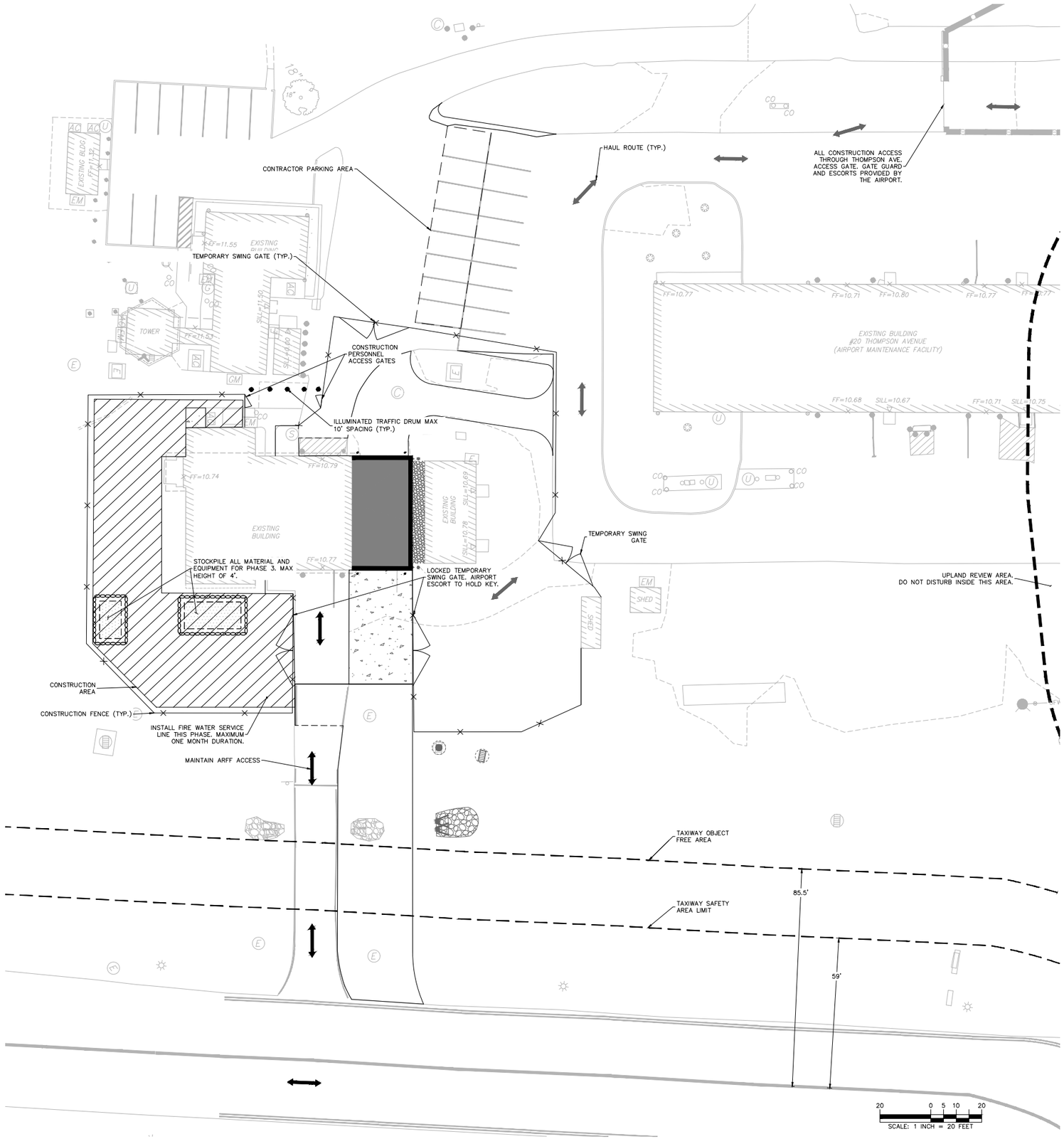
Project
TWEED-NEW HAVEN AIRPORT ARFF FACILITY RENOVATIONS
EAST HAVEN CONNECTICUT

Drawing Title
CONSTRUCTION SAFETY AND PHASING PLAN PHASE 2

Project No.	Drawing No.
140318901	KT202
Date: 05/13/2025	
Drawn By: BTM	
Checked By: JDD	

LANGAN Project No. 140318901



GENERAL NOTES

1. BOUNDARY AND TOPOGRAPHIC INFORMATION WAS OBTAINED FROM A PLAN TITLED "TOPOGRAPHIC SURVEY" FOR TWEED AIRPORT ARFF FACILITY RENOVATIONS BY LANGAN, DATED APRIL 15, 2025. COORDINATES REFERENCED TO NAD83 AND NAVD88 IN COMBINATION WITH TWEED AIRPORT PRIMARY AIRPORT CONTROLS AND SECONDARY AIRPORT CONTROLS.
2. THE SITE IS LOCATED IN A COASTAL ZONE AE (SHADED), AN AREA SUBJECT TO COASTAL FLOODING WITH MODERATE WAVE ACTION PER FIRM MAP 09009C0444J, EFFECTIVE DATE JULY 8, 2013. BASE FLOOD ELEVATION IS 12' NAVD88.
3. ADDITIONAL SITE AND UTILITY INFORMATION WAS OBTAINED FROM A PLAN TITLED "SITE PLAN" FOR TWEED AIRPORT TEMPORARY SECURITY FENCE AND PARKING PREPARED BY LANGAN AND DATED 09/13/2024.

WORK AREA NOTES

PROJECT DURATION:

- ALL WORK MUST BE COMPLETED WITHIN THE 10 MONTH PROJECT DURATION
- ALL WORK THIS PHASE SHOULD BE COMPLETED IN ONE MONTH

WORK ITEMS:

- RELOCATE PHASE 2 ILLUMINATED TRAFFIC DRUMS.
- INSTALL TEMPORARY CONSTRUCTION FENCE ENCLOSURE FOR PHASE 3.
- TRENCH FIRE WATER SERVICE LINE FROM PORTION COMPLETED IN PHASE 2 TO ARFF BUILDING.
- INSTALL FIRE HYDRANT.
- CLEAN, FLUSH, AND PRESSURE TEST FIRE WATER LINE INSTALLATION PER UTILITY PROVIDER REQUIREMENTS.
- REMOVE SAFETY EQUIPMENT, TEMPORARY CONSTRUCTION FENCE AND BARRIERS, AND EXCESS MATERIAL AT COMPLETION OF CONSTRUCTION.

OPERATIONAL IMPACTS:

- NONE THIS PHASE

WORK AREA VISUAL AIDS:

- CONSTRUCTION FENCE
- ILLUMINATED TRAFFIC DRUMS

WORK HOURS:

- THE CONTRACTOR IS PERMITTED TO WORK BETWEEN 7 AM AND 5 PM UNLESS EXTENDED HOURS ARE AUTHORIZED BY THE AIRPORT.

PHASING NOTES:

1. CONTRACTOR ESCORT SHALL REMAIN WITH CONSTRUCTION CREW AT ALL TIMES.
2. CONTRACTOR SHALL COMMUNICATE WITH ESCORT PRIOR TO EXITING THE DESIGNATED CONSTRUCTION AREA.
3. DRIVEWAY ACCESS TO THE EXISTING ARFF GARAGE BAY MUST BE MAINTAINED AT ALL TIMES THIS PHASE.
4. THOMPSON AVE. ACCESS GATE MUST REMAIN CLEAR AT ALL TIMES FOR EMERGENCY VEHICLE ACCESS.
5. OWNER SHALL PROVIDE GATE GUARD TO BE STATIONED AT THOMPSON AVE. ACCESS GATE DURING WORKING HOURS. OWNER SHALL PROVIDE ESCORT FOR COMMUNICATING WITH ARFF, ATC, AND AIRPORT GROUND OPERATIONS.
6. MAXIMUM HEIGHT OF CONSTRUCTION EQUIPMENT IS 33' ABOVE GRADE.
7. CONSTRUCTION PERSONNEL SHOULD ACCESS THE CONSTRUCTION AREA VIA THE CONSTRUCTION ACCESS GATES LOCATED TO THE FRONT OF THE ARFF BUILDING.

LEGEND

	EXISTING	PROPOSED
BUILDING LINE		
BITUMINOUS CONCRETE PAVEMENT		
CONCRETE PAVEMENT		
CATCH BASIN		
UTILITY MANHOLE		
FIRE HYDRANT		
CONSTRUCTION AREA THIS PHASE		
LOW PROFILE BARRICADE		
CONSTRUCTION FENCE		
AREAS OPEN TO AIRCRAFT		
TEMPORARY SAFETY FENCE		
ILLUMINATED TRAFFIC DRUMS		
CONTRACTOR HAUL ROUTE		
ARFF VEHICLE ACCESS ROUTE		
TEMPORARY STOCKPILE		

Date	Description	No.
Revisions		

Signature Date

Christopher Cardany
PEN. 21995

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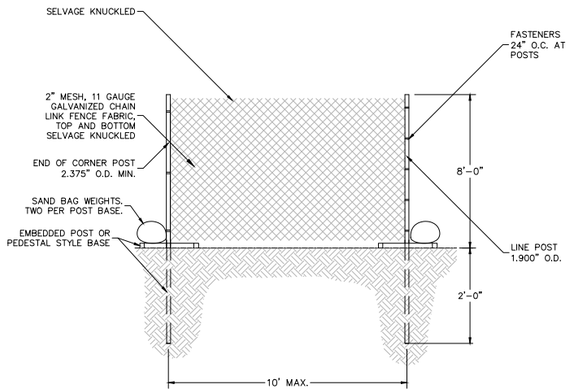
Project
TWEED-NEW HAVEN AIRPORT ARFF FACILITY RENOVATIONS
EAST HAVEN CONNECTICUT

Drawing Title
CONSTRUCTION SAFETY AND PHASING PLAN PHASE 3

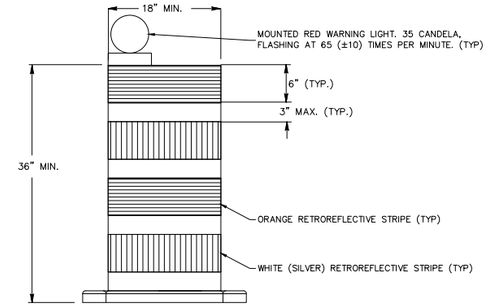
Project No.	Drawing No.
140318901	KT203
Date: 05/13/2025	
Drawn By: BTM	
Checked By: JDD	

LANGAN
Project No. 140318901



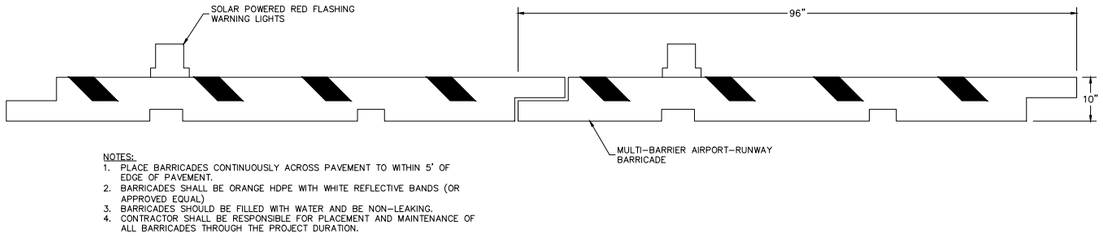
NOTES:
1. PIPE POSTS SHALL BE IMBEDDED INTO THE GROUND. PEDESTAL MOUNTED FENCING SHOULD BE USED IN AREAS WITH UNDERGROUND UTILITIES AS SHOWN ON THE SURVEY.
2. PROVIDE CONCRETE OR GALVANIZED-STEEL PEDISTAL BASES FOR SUPPORTING POSTS.

1 CONSTRUCTION FENCE
N.T.S.



NOTES:
1. TRAFFIC DRUM SHALL CONFORM TO THE REQUIREMENTS OF NCHRP REPORT 350 (TL-3) AND THE LATEST EDITION OF THE MUTCD.
2. THE ENGINEER RESERVES THE RIGHT TO REJECT ANY DRUM DEEMED UNSUITABLE FOR THE PURPOSE INTENDED.
3. THE ENTIRE AREA OF ORANGE AND WHITE STRIPES SHALL BE RETROREFLECTIVE SHEETING AS REQUIRED IN THE SPECIFICATIONS.
4. THE SECTIONS OF DRUMS NOT COVERED WITH RETROREFLECTIVE STRIPES SHALL BE ORANGE.
5. DRUMS SHALL BE WEIGHTED WITH SAND BAGS IN PAVED AREAS AND STAKED DOWN IN UNPAVED AREAS.

2 ILLUMINATED TRAFFIC DRUM
N.T.S.



NOTES:
1. PLACE BARRICADES CONTINUOUSLY ACROSS PAVEMENT TO WITHIN 5' OF EDGE OF PAVEMENT.
2. BARRICADES SHALL BE ORANGE HDPE WITH WHITE REFLECTIVE BANDS (OR APPROVED EQUAL)
3. BARRICADES SHOULD BE FILLED WITH WATER AND BE NON-LEAKING.
4. CONTRACTOR SHALL BE RESPONSIBLE FOR PLACEMENT AND MAINTENANCE OF ALL BARRICADES THROUGH THE PROJECT DURATION.

3 LOW PROFILE CONSTRUCTION BARRICADE
N.T.S.

NOTES:
1. FENCE TO BE SECURELY FASTENED TO 6' HARDWOOD STAKES DRIVEN INTO THE GROUND, 8' ON CENTER.
2. FENCE SHALL BE ORANGE.

4 SAFETY FENCE
N.T.S.

Date	Description	No.
Revisions		

Signature Date

Christopher Cardany
PEN. 21995

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Project

TWEED-NEW HAVEN AIRPORT ARFF FACILITY RENOVATIONS

EAST HAVEN CONNECTICUT

Drawing Title

CONSTRUCTION SAFETY AND PHASING DETAILS

Project No.	Drawing No.
140318901	KT601
Date: 05/13/2025	
Drawn By: BTM	
Checked By: JDD	

LANGAN Project No. 140318901

Date: 5/21/2025 Time: 16:29 User: bmichaelis Style Table: Langan.stb Layout: KT501 Document Code: 140318901-0501-KT501-0101

State of Connecticut

Department of Transportation

STANDARD SPECIFICATIONS

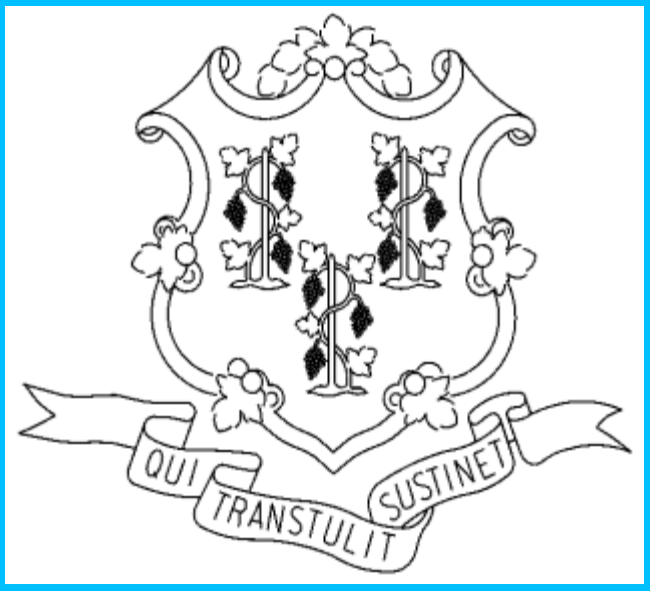
FOR

ROADS, BRIDGES, FACILITIES

AND INCIDENTAL CONSTRUCTION

FORM 819

2024



CONNECTICUT DEPARTMENT OF TRANSPORTATION

Garrett T. Eucalitto, Commissioner

STANDARD SPECIFICATIONS COMMITTEE

Scott A. Hill, P.E., Chief Engineer

Eileen Ego, P.E., Chair

Janet L. Mazeau, P.E., Specifications Engineer

MEMBERS

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John Antonucci, P.E.	District 3, Construction
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Eric P. Belanger	Office of Construction, Specifications Section
David Nardone	Federal Highway Administration
Philip J. Orzech, Esq.	Bureau of Engineering and Construction
Julio Rivera	Federal Highway Administration
Donald Shubert	Connecticut Construction Industries Association

The following past members are acknowledged for their contributions:

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Susan L. Fiedler	Landscape Design
Sara Ghatee	Soils and Foundations
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Jane D. Witherell	Division of Construction Operations

These Connecticut Department of Transportation *Standard Specifications for Roads, Bridges, Facilities, and Incidental Construction*, Form 819 dated January 2024, are hereby approved for application on highway and related construction contracts as referenced in the Contract plans or Special Provisions, and they shall apply as noted and amended by those documents. These electronic *Standard Specifications* and any Supplements are adopted as the official documents. Printed copies are not considered official and will no longer be provided.

I hereby certify that these *Standard Specifications* were prepared by me or under my responsible charge, were compiled from specifications prepared, examined, adopted and implemented by the Connecticut Department of Transportation in accordance with established procedures, and have been approved by the Chief Engineer Scott A. Hill and the Federal Highway Administration.

Janet L. Mazeau, P.E.

CTDOT Specifications Engineer

STANDARD SPECIFICATIONS FOR ROADS, BRIDGES, FACILITIES AND INCIDENTAL CONSTRUCTION
FORM 819

2024

These Standard Specifications – Form 819, in a searchable document format, may be accessed on the Department's internet site:
Click on "Do Business with CTDOT" under "Publications" choose "Specifications for Roads, Bridges, & Incidental Construction etc.," then click on "Form 819" at:

https://portal.ct.gov/DOT

NOTE: Adobe Reader is recommended.

A vertical rule beside the paragraph, table, or figure indicates the location a change occurred.

ITEM NUMBERING SYSTEM

Item numbers, appearing in the Contract for roadway, bridge, facilities, and incidental construction consist of a 7-digit number which may be followed by a 2-digit decimal extension. The first 4 digits denote the Section number of the Standard Specification, Supplemental Specification, or Special Provision under which the item is to be constructed. The remaining digits are for Departmental coding purposes.

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*Specification Not Included

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Division II
CONSTRUCTION DETAILS

*Specification Not Included

EARTHWORK

SURFACE COURSES OR PAVEMENTS

STRUCTURES

*Specification Not Included

INCIDENTAL CONSTRUCTION

*Specification Not Included

TRAFFIC CONTROL

*Specification Not Included

Section **Rev Date, Notes**

*Specification Not Included

Division III
MATERIALS SECTION

DIVISION I
GENERAL REQUIREMENTS AND COVENANTS

SECTION 1.01
DEFINITION OF TERMS AND
PERMISSIBLE ABBREVIATIONS

1.01.01—Definitions
1.01.02—Abbreviations, Publications and Standards
1.01.03—Abbreviations and Terms

1.01.01—Definitions: In these specifications, unless the context requires otherwise, words of the masculine gender include the feminine and the neuter, and, when the sense so indicates, words of the neuter gender may refer to any gender. Where appropriate, words in the singular form shall be deemed to include the plural, and words in the plural form to include the singular.

ADDENDUM: Contract revisions developed and incorporated into the contract after bid advertisement and before the opening of bid proposals.

AIR OPERATIONS AREA: Any paved or unpaved area of the airport used or intended to be used for the unobstructed movement of aircraft. These movements shall include landings, takeoffs, and surface maneuverings.

AWARD: The Department's acceptance in writing of the proposal of the lowest responsible bidder for the work, subject to the execution and approval by the Department of a contract therefor and the provision by the bidder of performance and payment bonds to secure the performance thereof which are acceptable to the Commissioner, and to such other conditions as may be specified by the Department or required by law.

BID: The submission of a proposal for the work contemplated.

BID ADVERTISEMENT: A public announcement requesting bids for a contract for work to be performed or materials to be furnished.

BIDDER: An individual or legal entity submitting a proposal in response to an advertised request.

BID MANUAL: "The State of Connecticut Department of Transportation Construction Contract Bidding and Award Manual," copies of which are available from the Department's Division of Contracts and at the following link: Construction Contract Bidding and Award Manual

CALENDAR DAY: Every day shown on the calendar, beginning, and ending at midnight.

CATALOG CUT (PRODUCT DATA): Document(s) with information such as manufacturer's product specifications, manufacturer's installation instructions, standard color charts, wiring diagrams showing factory-installed wiring, printed performance curves and operational range diagrams. Product data that must be specially prepared because standard printed data is not suitable shall be considered shop drawings.

CERTIFICATE OF COMPLIANCE: The formal document issued at the completion of a project by the State Building Inspector's representative. The document is often referred to informally as a "Certificate of Occupancy," "C.O.C." or "C.O."

CHANNEL: A channel shall be interpreted to mean a natural or artificial watercourse having an average width at the bottom, after excavation, of 4 feet or more.

COMMISSIONER: State of Connecticut Transportation Commissioner acting directly or through a duly authorized representative.

CONNECTICUT GUIDELINES FOR SOIL EROSION AND SEDIMENT CONTROL: This DEEP Bulletin is intended to provide information to government agencies and the public on soil erosion and sediment control.

CONNECTICUT STORMWATER QUALITY MANUAL: This DEEP publication provides guidance on measures necessary to protect waters of the State from adverse impacts of post-construction stormwater runoff.

CONSTRUCTION ORDER, CHANGE ORDER: A written order signed by the Engineer for a contractor to perform work or provide supplies stipulated therein at the price or upon the basis of payment set forth therein.

CONTRACT: The agreement covering the performance of the work and the furnishing of materials required for the construction of the Project. The Contract shall be deemed to include the "Plans," "Specifications" (*i.e.*, the Department's "Standard Specifications for Roads, Bridges, Facilities and Incidental Construction" which is in effect on the date of the Bid Advertisement), "Construction Orders," and such other provisions as may be incorporated into the agreement, in addition to the contents of the

signed contract containing the schedule of prices, signature sheet, addenda, special provisions, required federal and State provisions, supplemental specifications, labor and wage schedules, permits and other such material.

CONTRACTOR: Individual or legal entity contracting with the Department to perform the work. When the word is capitalized, it refers to the party of the second part to the Contract, acting directly or through its agents or employees. When this word is not capitalized, it is to be taken in its more general sense.

CONTRACT PAY ITEM: Specific work unit for which the Contract provides a price.

COUNTY: The largest State administrative division used to designate or identify the location of the proposed work.

CULVERT: A covered channel or a large pipe for carrying a watercourse below ground level, usually under a road or railway.

DEPARTMENT: State of Connecticut Department of Transportation.

DESIGNER: A duly authorized representative of the Engineer, responsible for the design of the Project.

DRAINAGE DITCH: A paved or unpaved, artificially constructed open depression having an average width of less than 4 feet at the bottom, after excavation, constructed for the purpose of carrying off surface water.

ENGINEER: The Commissioner or Deputy Transportation Commissioner, acting directly or through a duly authorized representative.

EQUAL: A material, device, type of equipment, or method other than what is specified in the Contract, which is a recognized equivalent in substance and function for that specified thing, taking into account warranty, performance, weight, size, visual effect, special features and requirements indicated, quality, workmanship, economy of operation, durability, and suitability for purposes intended, provided that the proposed equivalent would not require or constitute a change in Contract work.

EXECUTION OF CONTRACT: The date of execution of the Contract by the Department is the date on which the Department's authorized signatory signs the Contract on behalf of the Department.

HIGHWAY: A general term denoting a public way used for vehicular travel. When referred to in the Contract, it signifies the whole right of way reserved for or secured by the Department for use in constructing or maintaining a roadway and its appurtenances.

INSPECTOR: A duly authorized representative of the Engineer, assigned to make inspections of the work performed and associated materials.

LABORATORY: Department testing facility or other designated testing laboratory**.**

LIQUIDATED DAMAGES: The amount prescribed in the Contract specifications, to be paid to the State or to be deducted from any payments due or to become due the Contractor, for a specified time unit delay in completing the whole or any specified portion of the work beyond the time allowed in the Contract.

MAJOR ITEM: An individual Contract item, whose value at the time of bidding (either lump sum price or the product of its unit price multiplied by its estimate quantity) is equal to or greater than 10% of the total original Contract bid price shall be considered a Major Item.

MANAGER OF CONTRACTS: The Transportation Manager of Contracts, who is the head of the Department's Division of Contracts, at email address DOTContracts@ct.gov and whose office is located at the headquarters of the Department at 2800 Berlin Turnpike, Newington, CT, 06111.

MATERIAL: Any substance specified in the Contract for use in the construction of the Project, including appurtenances of products that are substantially shaped, cut, worked, mixed, finished, refined, or otherwise fabricated, processed, or installed in order to be used for the Project work or become part of the constructed Project.

MILESTONE: An identified point of progress in the timeline of the Project.

MINOR ITEM: An individual Contract item that is not a Major Item.

MUNICIPALITY: City, town, or county.

NOTICE TO PROCEED: Written direction to the Contractor stipulating the date for beginning the Work subject to other Contract requirements, including the date from which project time will be charged.

OWNER: Where used herein, it is synonymous with Department or State.

PAVEMENT STRUCTURE: The combination of sub-base, base course and surface course placed on subgrade to support and distribute the traffic load.

PLANS: Contract drawings showing location, type, dimensions, and details of specified work. This includes Standard Sheets.

PRODUCT DATA (CATALOG CUT): Document(s) with information such as manufacturer's product specifications, manufacturer's installation instructions, standard color charts, wiring diagrams showing

factory-installed wiring, printed performance curves and operational range diagrams. Product data that must be specially prepared because standard printed data is not suitable shall be considered shop drawings.
PROJECT: All work included under one Department Contract. The Department may use multiple project numbers for the work included within one Contract.
PROJECT SITE (*or* SITE): The space available to the Contractor, under the Contract, for performing construction activities. The extent of the Project site is as indicated on the plans or elsewhere in the Contract.
QUALIFIED PRODUCTS LIST (QPL): A report that has been developed as a means for determining what products, suppliers, manufacturers, equipment, and methodologies may be used on construction projects. This report is located on the CT Department of Transportation Website:
Connecticut DOT Qualified Products List Report
RECLAIMED CONCRETE AGGREGATE: Reclaimed waste consisting of crushed and graded concrete removed from pavements, structures, or buildings. Metal may be acceptable only where it is contained as reinforcement within small fragments of concrete, *e.g.*, metal projecting from concrete fragments would be unacceptable. All such material trucked from beyond the limits of the Project must be accompanied by a Materials Certificate and Certified Test Report indicating that the material is environmentally acceptable and structurally sound in accordance with 1.06.07, unless the source of the material is a Department Project, and that source is acceptable to the Engineer.
RECLAIMED MISCELLANEOUS AGGREGATE: Glass-free and clinker-free reclaimed waste, that has been crushed, graded and blended, as specified in the Contract, with natural crushed stone or gravel. Metal may be acceptable only where it is contained as reinforcement within small fragments of concrete, *e.g.*, metal projecting from concrete fragments would be unacceptable. All such material trucked from beyond the limits of the Project must be accompanied by a Materials Certificate and Certified Test Report indicating that the material is environmentally acceptable and structurally sound in accordance with 1.06.07, unless the source of the material is a Department Project, and that source is acceptable to the Engineer.
RECLAIMED WASTE: Debris from the demolition of buildings, structures, and pavements; residue from incineration and recycled glass. Acceptable material shall include concrete, bituminous concrete, glass, ceramics, brick, pavement sub-base and base courses, and clinker from resource recovery plants. Metal may be acceptable only when it is contained within large fragments of concrete. Reclaimed waste trucked from beyond the limits of the Project must be accompanied by a Materials Certificate and Certified Test Report indicating that the waste is environmentally acceptable and structurally sound in accordance with 1.06.07, unless the source of the material is a Department Project, and that source is acceptable to the Engineer.
RESOURCES: The labor, equipment, and material necessary to perform work on a Contract bid item or other element of work.
RIGHT-OF-WAY: Land, property, or interest therein acquired for or devoted to transportation purposes.
ROADBED: The graded portion of a highway, including portions within the top and side slopes, that has been prepared as a foundation for the pavement structure and shoulders.
ROADWAY: The portion of the highway, including shoulders, which may be used for vehicular travel within the Project limits.
SHOP DRAWINGS: Drawings, including proposed details, diagrams, schedules, procedures, and other supporting data, prepared by a Contractor to supplement the Contract documents, showing all information necessary for fabrication of items for which some specific design or detail appears in the Contract.
SHOULDER: The portion of the roadway adjacent to the Traveled Way, that can accommodate stopped vehicles for emergency use, and that provides lateral support of base and surface courses.
SPECIFICATIONS: The Department's written provisions and requirements for the performance of the Contract, contained in or incorporated by the Contract.

A. *Standard Specifications*—A set of specifications approved by the Department for general application and repetitive use, entitled the "Standard Specifications for Roads, Bridges, Facilities and Incidental Construction" found at the following link:
Standard Specifications for Roads, Bridges, Facilities and Incidental Construction
B. *Supplemental Specifications*—Approved additions to and revisions of the Standard Specifications.
C. *Special Provisions*—Other Department specifications applicable to an individual project.

STATE: State of Connecticut.
STANDARD SHEETS: Standardized plans containing details approved by the Department and the

FHWA, for construction of a given type on any project, included in contracts on an as-needed basis.
SUBCONTRACTOR: Any individual, firm, partnership, or corporation to which the Contractor sublets, with the approval of the Commissioner, any part or parts of the Project covered by the Contract.
SUBSTANTIAL COMPLETION: The date at which the performance of all work on the Project has been completed except minor or incidental items, final cleanup, work required under a warranty and repair of unacceptable work, and provided the Engineer has determined that:

A. The Project is safe and convenient for use by the public, and
B. All traffic lanes including all safety appurtenances are in their final configuration, and
C. Failure to complete the work and repairs excepted above does not result in the deterioration of other completed work, and provided further, that the value of work remaining to be performed, and cleanup is less than one percent (1%) of the estimated final Contract amount, and
D. If applicable a Certificate of Compliance has been issued.

SUBSTITUTE: A replacement for a specified material, device, type of equipment, or method, which is sufficiently different in substance and function, quality, or workmanship to constitute a change in the Contract work.
SUBSTRUCTURE: All of that part of the bridge below the bearings of simple and continuous spans, skewbacks of arches and tops of footings of rigid frames, including backwalls, wingwalls and any protective railings mounted on the wingwalls.
SUB-SUBCONTRACTOR: Any individual, firm, partnership, or corporation to which a subcontractor sublets, with the approval of the Commissioner, any part or parts of the Project covered by the Contract.
SUPERSTRUCTURE: The entire bridge except the substructure.
TRAVELED WAY: Portion of the right-of-way designated for vehicle use, excluding shoulders.
UTILITY: Any public service company and the plant of such a company or similar facilities. Such companies may consist of, but not be limited to, companies selling or controlling the sale, distribution or use of water, gas, electricity, communications systems, sewers, and railroad lines. Such facilities may consist of, but not be limited to, wires, cables, ducts, pipes, manholes, transformers, poles, towers, and tracks.
WATERCOURSE: Rivers, streams, brooks, waterways, lakes, ponds, marshes, swamps, bogs, and all other bodies of water, natural or artificial, vernal, or intermittent, public or private, which are contained within, flow through or border upon this state.
WORK: The provision of labor, materials, or services necessary for or relating to the design and construction of the Project.
WORKING DRAWINGS: Drawings, calculations, procedures, and other supporting data prepared by a Contractor, documenting the Contractor's proposed design, details, materials, construction methods and equipment for any construction for which no specific design or detail appears in the Contract.

1.01.02—Abbreviations, Publications and Standards: For publications and standards, the edition governing the Project work will be the edition in effect on the date the Contract was advertised for solicitation of bids. Whenever one of the following abbreviations is used in the Contract, its meaning shall be interpreted as follows:

AA—(The) Aluminum Association, Inc.
AABC—Associated Air Balance Council
AAMA—American Architectural Manufacturers Association
AAN—American Association of Nurserymen
AAPA—American Association of Port Authorities
AASHTO—American Association of State Highway and Transportation Officials
NOTE: Wherever reference is made to an AASHTO Standard Method of Test or Standard Specification, it refers by letter and number to the method or specification published by AASHTO in the "Standard Specifications for Transportation Materials and Methods of Sampling and Testing."
AASHTO Product Evaluation and Audit Solution—A materials testing service program of AASHTO (*formerly* NTPEP)
AASHTO re:source—A technical service program of AASHTO
ABMA—American Bearing Manufacturers Association
ACGIH—American Council of Government Industrial Hygienists
ACI—ACI International (American Concrete Institute)
ACMA —American Composites Manufacturers' Association

ACOE—Army Corps of Engineers
ADA—Americans with Disabilities Act
ADAAG—Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities
ADSC—The International Association of Foundation Drilling (formerly Association of Drilled Shaft Contractor)
AFBMA—Anti-Friction Bearing Manufacturer's Association
AF&PA—American Forest & Paper Association
AGA—American Gas Association
AGC—(The) Associated General Contractors of America
AGMA—American Gear Manufacturer's Association
AHA—American Hardboard Association
AHAM—Association of Home Appliance Manufacturers
AI—Asphalt Institute
AIA—(The) American Institute of Architects
AISC—American Institute of Steel Construction
AISI—American Iron and Steel Institute
AITC—American Institute of Timber Construction
A.L.I.—Automotive Lift Institute
ALSC—American Lumber Standard Committee, Incorporated
AMCA—Air Movement and Control Association International, Inc.
AMPP—The Association for Materials Protection and Performance [*formerly* NACE and SSPC]
AMS—Aerospace Material Specification
ANLA—American Nursery and Landscape Association
ANSI—American National Standards Institute
AOAC—AOAC International
AOSA—Association of Official Seed Analysts
APA—APA-The Engineered Wood Association
APWA—American Public Works Association
API—American Petroleum Institute
AREMA—American Railway Engineering and Maintenance-of-Way Association
ARI—Air-Conditioning & Refrigeration Institute
ARTBA—American Road and Transportation Builders Association
ASA—Acoustical Society of America
ASC—Adhesive and Sealant Council
ASCE—American Society of Civil Engineers
ASHRAE—American Society of Heating, Refrigerating and Air-Conditioning Engineers
ASME—ASME International (The American Society of Mechanical Engineers International)
ASNT—American Society for Non-Destructive Testing
ASSE—American Society of Sanitary Engineering
ASTM—American Society of Testing and Materials (ASTM International)
NOTE: Wherever reference is made to an ASTM specification, test method, or practice, it refers by letter, number, or both to standards published by ASTM International in the "ASTM Standards Source™ Database."
ATSSA—American Traffic Safety Services Association
AWI—Architectural Woodwork Institute
AWPA—American Wood Protection Association (*formerly* American Wood-Preservers' Association)
AWPI—American Wood Preservers Institute
AWS—American Welding Society
NOTE: Wherever reference is made to an AWS materials specification, inspection methods, or welding procedures, it refers by section number to standards of the American Welding Society published in the applicable steel, or aluminum welding code.
AWWA—American Water Works Association
BAA—Buy America Act
BABA—Build America, Buy America Act
BGFMA—Bridge Grid Flooring Manufacturer's Association
BHMA—Builders Hardware Manufacturers Association

BIA—(The) Brick Industry Association
BOCA—BOCA International, Inc.
CBM—Certified Ballast Manufacturers Association
CCRL—Cement and Concrete Reference Laboratory
CDA—Copper Development Association (The)
CDMS— Construction Document Management System (*currently* COMPASS; link to COMPASS Contractor's User Manual)
CFR—Code of Federal Regulations
CGA—Compressed Gas Association
CGS—Connecticut General Statutes (as revised)
CISCA—Ceilings and Interior Systems Construction Association
CISPI—Cast Iron Soil Pipe Institute
CLFMI—Chain Link Fence Manufacturers Institute
CMRS— Construction Management Reporting System (*currently* AASHTOWare; link to AASHTOWare Contractor's User Manual)
ConnDOT—Connecticut Department of Transportation
CRI—(The) Carpet and Rug Institute
CRSI—Concrete Reinforcing Steel Institute
CSI—(The) Construction Specifications Institute
CSSB—Cedar Shake & Shingle Bureau
CTDOT—Connecticut Department of Transportation
CTI—Cooling Technology Institute
DASMA—Door and Access Systems Manufacturers Association, International
DEEP—Connecticut Department of Energy and Environmental Protection
DHI—Door and Hardware Institute
DOD—Department of Defense Military Specifications and Standards
EIA—Electronic Industries Alliance
EPA—Environmental Protection Agency
ETL—Edison Testing Laboratories
FAA—Federal Aviation Administration
FCC—Federal Communications Commission
FCICA—Floor Covering Installation Contractors Association
FHWA—Federal Highway Administration
FMG—FM Global
FRA—Federal Railway Administration
FS—Federal Specification
NOTE: Wherever reference is made to FS in the contract, it refers by number, letter, or both, to the latest standard or tentative standard of the Federal Specification Unit, General Services Administration, Federal Supply Service, as to materials, specifications, or methods of testing, whichever applies.
FTA—Federal Transit Administration
GA—Gypsum Association
GANA—Glass Association of North America
GSA—General Services Administration
HI—Hydraulics Institute
HPVA—Hardwood Plywood & Veneer Association
IAS—International Accreditation Service
IBC—International Building Code
ICC—International Code Council
ICC-ES—ICC Evaluation Service, Inc.
ICEA—Insulated Cable Engineers Association, Inc.
ICRI—International Concrete Repair Institute
IEC—International Electrotechnical Commission
IEEE—(The) Institute of Electrical and Electronics Engineers, Inc.
IES—Illuminating Engineers Society
IESNA—Illuminating Engineering Society of North America
IGCC—Insulating Glass Certification Council

IGMA—Insulating Glass Manufacturers Alliance
IMSA—International Municipal Signal Association
IRI—HSB Industrial Risk Insurers
ISO—International Organization for Standardization
ITE—Institute of Transportation Engineers
ITSNA—Intertek Testing Services, Inc. (*formerly* Edison Testing Laboratories)
IUPAT—International Union of Painters and Allied Trades
KCMA—Kitchen Cabinet Manufacturers Association
LMA—Laminating Materials Association
LPI—Lightning Protection Institute
LWRD—Land and Water Resources Division
MASH—Manual for Assessing Safety Hardware
MBMA—Metal Building Manufacturers Association
MILSPEC—Military Specification and Standards
MMA—Monorail Manufacturers Association
MSHA—Mine Safety and Health Administration
MSS—Manufacturers Standardization Society of The Valve and Fittings Industry, Inc.
MUTCD—Manual on Uniform Traffic Control Devices
NAAMM—National Association of Architectural Metal Manufacturers
NADCA—National Air Duct Cleaners Association
NAIMA—(The) North American Insulation Manufacturers Association
NBFU—National Board of Fire Underwriters
NCHRP—National Cooperative Highway Research Program
NCMA—National Concrete Masonry Association
NCPI—National Clay Pipe Institute
NCSPA—National Corrugated Steel Pipe Association
NEAUPG—NorthEast Asphalt User/Producer Group
NEBB—Natural Environmental Balancing Bureau
NEC—National Electrical Code
NECA—National Electrical Contractors Association
NEMA—National Electrical Manufacturers Association
NEPCOAT—North East Protective Coatings Committee
NESC—National Electrical Safety Code
NETA—InterNational Testing Association
NETTCP—NorthEast Transportation Technician Certification Program
NFPA—National Fire Protection Association
NFRC—National Fenestration Rating Council
NHLA—National Hardwood Lumber Association
NICET—National Institute for Certification in Engineering Technologies
NIOSH—National Institute of Occupational Safety and Health
NIST—National Institute of Standards and Technology
NLGA—National Lumber Grades Authority
NMFS–National Marine Fisheries Service
NOAA—National Oceanic and Atmospheric Administration
NPCA—National Precast Concrete Association
NRCA—National Roofing Contractors Association
NRMCA—National Ready-Mixed Concrete Association
NSBA—National Steel Bridge Alliance
NSC—National Safety Council
NSF—NSF International
NTMA—National Terrazzo and Mosaic Association, Inc.
OEO—Office of Equal Opportunity
OIS—Office of Information Systems
OSHA—Occupational Safety and Health Administration
OSTA—Office of the State Traffic Administration
PCA—Portland Cement Association

PCI—Precast/Prestressed Concrete Institute
PDI—Plumbing & Drainage Institute
PROWAG—Public Right-of-Way Accessibility Guidelines
PTI—Post-Tensioning Institute
PURA—Public Utilities Regulatory Authority
RCSA—Regulations of Connecticut State Agencies
RCSC—Research Council on Structural Connections
RMA—Rubber Manufacturers Association
SAE—SAE International (formerly Society of Automotive Engineers)
SDI—Steel Deck Institute *or*
.....—Steel Door Institute
SFPA—Southern Forest Products Association
SHRP—Strategic Highway Research Program
SJI—Steel Joist Institute
SMACNA—Sheet Metal and Air Conditioning Contractors National Association
SPIB—(The) Southern Pine Inspection Bureau
SPRI—Single Ply Roofing Institute
SSPC—*see* AMPP

NOTE: Where reference is made to SSPC in the Contract, it refers by number, letter, or both, to the latest standard or tentative standard specification as to materials specifications, methods of testing, systems, procedures, inspection or other specification pertaining to any or all phases of cleaning or painting, whichever may apply.

SWRI—Sealant, Waterproofing, & Restoration Institute
TCA—Tile Council of America, Inc.
TIA—Telecommunications Industry Association
TIA/EIA—Telecommunications Industry Association/Electronics Industries Alliance
TMS —the Masonry Society
TPI—Truss Plate Institute, Inc.
TRB—Transportation Research Board
UFAS—Uniform Federal Accessibility Standards
UL—Underwriters Laboratories Inc.
USACE—United States Army Corps of Engineers (*formerly* USACOE)
USCG—United States Coast Guard
USDA—United States Department of Agriculture
USFWS–United States Fish and Wildlife Service
USGBC—U.S. Green Building Council
USSWG—United States Steel Wire Gauge
WCLIB—West Coast Lumber Inspection Bureau
WCSC—Window Covering Safety Council
WDMA—Window & Door Manufacturers Association
WWPA—Western Wood Products Association

1.01.03—Abbreviations and Terms: Abbreviations and terms used in the Contract are in lieu of and are to be construed in the same way as are the terms or phrases following them in the list below. Those abbreviations and terms include, but are not necessarily limited to:

ABS—acrylonitrile butadiene styrene
AC—alternating current
ACCM Pipe or ACCMP—Asphalt-Coated Corrugated Metal Pipe
ACSR—Aluminum Conductor, Steel Reinforced
A.E.A.—Air Entraining Admixture
AIC—Ampere Interrupting Current
AOEC—Area of Environmental Concern
APA—Aquifer Protection Area
AWG—American Wire Gauge
B & B—balled and burlapped
bbl—barrel

BCPC—Bituminous Concrete Park Curbing
Bit.—bituminous
Bit. Conc.—bituminous concrete
CAPWAP—CAse Pile Wave Analysis Program
CAS—Coating Applicator Specialist
CB—catch basin
CCA—chromated copper arsenate
CCM Pipe or CCMP—coated corrugated metal pipe
CICU—controller interface communications unit
CLLCU—closed loop local coordination unit
CLMU—closed loop master unit
CMS—Changeable Message Sign
CMU—concrete masonry unit
Conc.—concrete
CPE Pipe or CPEP—corrugated plastic or polyethylene pipe
CPS—centipoise second
CTR—Certified Test Report
CUF—Commercially Useful Function
CWI— Certified Welding Inspector
cwt.—hundredweight or 100 pounds
DBE—Disadvantaged Business Enterprise
DBH—Diameter at breast height
DC—direct current
dist.—distillation
DPDM—Digital Project Development Manual
DTI—Direct Tension Indicator
EW—endwall
est.—estimated
exc—excavation
fc—foot-candle
fi—jacking tension
FRC—Fiberglass Reinforced Composite
f' c—specified minimum compressive strength at a specified age
f' ci—required strength at time of transfer
ga—gauge or gage
GFRP—glass fiber reinforced polymer
Gsa—Apparent specific gravity
Gsb—Bulk specific gravity
HASP—Health and Safety Plan
HMA—hot mix asphalt or bituminous concrete
HRB—Rockwell B Scale hardness
HRC—Rockwell C Scale hardness
Hz—hertz
IMC—intermediate metal conduit
IP—internet protocol
I.P.S.—iron pipe size
IWRC—independent wire rope core
JMF—job mix formula
KD—kiln dried
KDAT—kiln dried after treatment
kip—1000 pounds
ksf—kips per square foot
LCD—Liquid Crystal Display
LED—light emitting diode
LID—Low Impact Development
LRFD—Load & Resistance Factor Design

l.s.—lump sum
MAA—mast arm assembly(ies)
mbf—1000-foot board measure
MBR—metal beam rail
MC—Materials Certificate
MESU—Material Evaluation and Specification Unit (*formerly* DMT)
M. gal—1000 gallons
MH—manhole
MLSI—Major Lump Sum Item
MS4—Municipal Separate Storm Sewer Systems
MPT—Maintenance and Protection of Traffic
N.C.—National Coarse
NDT—non-destructive testing
Pavt.—pavement
PCBC—precast concrete barrier curb
PCC—Portland Cement Concrete
PE—polyethylene
Perf. ACCM Pipe or Perf. ACCMP—Perforated Asphalt Coated Corrugated Metal Pipe
Perf. CCM Pipe or Perf. CCMP—Perforated Coated Corrugated Metal Pipe
Perf. CPE Pipe or Perf. CPEP—Perforated Corrugated Plastic or Polyethylene Pipe
pfmd.—preformed
PQR—procedure qualification record
PROM—programmable read only memory
psf—pounds per square foot
psi—pounds per square inch
p/s—prestressed
PTFE—polytetrafluoroethylene
PVC—polyvinyl chloride
Pwa—Percent water absorbed
QCPFA—Quality Control Plan for Fine Aggregates
RAP—reclaimed asphalt pavement
RC—Reinforced Concrete
RCCE—Reinforced Concrete Culvert End
RC Pipe *or* RCP—Reinforced Concrete Pipe
RFC—Request for Change
RFI—Request for Information
RMC—Rigid Metal Conduit
SD—system detector
SDR—Standard Dimension Ratio (ratio of pipe diameter to wall thickness)
sec.—second
SMT—surface-mount technology
sol.—soluble
S.O.W.—Service cord (Oil resistant jacket, Weather/water resistant)
sp. gr.—specific gravity
sp. visc.—specific viscosity
SSA—Sole Source Aquifer
SSP—Subspecies
std.—standard
surf.—surface
TBD—to be determined TDC—Transportation Division Chief
THHN—Heat resistant thermoplastic, insulated nylon jacket, 90°C, 600 V building wire
THWN—Moisture and heat resistant thermoplastic, insulated nylon jacket, 75°C, 600 V building wire
TL—Test Level
TMA—Truck Mounted Impact Attenuator
TMP—Transportation Management Plan
tsf—tons per square foot

TTC—Temporary Traffic Control
U'drain *or* Udrain—Underdrain
UNC—Unified National Coarse
UNS—Unified Numbering System
USB—Universal Serial bus
UTCS—urban traffic control system
UV—ultra-violet or ultraviolet light
VAC—Volts Alternating Current
VDC—Volts Direct Current
VECP—Value Engineering Change Proposal
VMS—Variable Message Sign
VOC—Volatile Organic Compound
VT—vitrified tile
W—watt
WPS—weld procedure specification
WSA—Temporary Waste Stockpile Area

SECTION 2.08
FREE-DRAINING MATERIAL

2.08.01—Description: Free-draining material shall consist of material meeting the requirements stated elsewhere herein. This material shall be furnished and placed in accordance with these specifications and as indicated on the plans, special provisions, or as ordered by the Engineer for the stabilization of embankments, or for fill in free water areas, or wherever specified.

2.08.02—Materials: Material for this work shall meet the requirements of M.02.07.

2.08.03—Construction Methods: The Contractor shall notify the Engineer at least 3 days prior to obtaining free-draining material from any source so that an examination may be made of the material and the necessary measurements may be taken.

The limits of the proposed source shall be shown to the Engineer; and prior to the taking of measurements, the Contractor shall be required to clear the area of all unsuitable material. No payment will be made for any material removed outside of the area measured or which was not used in the Contract work. No excavation shall be made within the confines of a source after the Engineer has taken the original measurements, except for material to be used for the purposes hereinbefore indicated, except with the permission of the Engineer.

The Contractor may, with the approval of the Engineer, obtain free-draining material, if available, from within the roadway excavation limits subject to the provisions of 1.04.07.

If the Contractor elects to obtain free-draining material from a commercial pit, it will be necessary to have a section of the pit set off for its use solely, so that the amount of material removed may be accurately determined. During the period between the original and the final release by the Engineer, no material shall be taken from a measured pit except by the Contractor and for use only in the work under the Contract.

If the Contractor elects to use stone from a quarry or reclaimed miscellaneous aggregate, the Contractor shall use only the materials from stockpiles which have been approved for use.

Free-draining material will be permitted only to the extent necessary to construct embankments to 3 feet above free water, or to promote free drainage in areas specified on the plans, in the special provisions, or as directed by the Engineer.

Free-draining material shall be placed in accordance with the provisions for the formation of embankment of 2.02.

2.08.04—Method of Measurement: The amount of free-draining material to be paid for will be determined by using the results of cross-sectional elevations taken before and after the free-draining material has been excavated in the average end area method, or by a method approved by the Engineer.

When material is drawn from a quarry stockpile or stockpile formed from reclaimed miscellaneous aggregate, the material shall be weighed on scales furnished by and at the expense of the Contractor. The scales shall be of a type satisfactory to the Engineer and shall be sealed at the expense of the Contractor as often as the Engineer may require. All weighing shall be done in the presence of a representative of the Department. From the weight so obtained, the volume shall be computed based on a specific gravity of 2.92 for the aggregate and smaller particles. For material having a different specific gravity, an appropriate correction shall be made.

2.08.05—Basis of Payment: Payment will be made at the Contract unit price per cubic yard for "Free-Draining Material," complete in place, which price shall include furnishing and placing the material and all equipment, tools and labor necessary thereto.

Pay Item	Pay Unit
Free-Draining Material	c.y.

SECTION 2.09
SUBGRADE

2.09.01—Description: The area upon which the pavement structure and paved shoulders are placed, including the shoulder base courses and subbase, shall be known as the subgrade. This is the plane coincident with the bottom of the subbase and the edge of pavement, as shown on the plans and cross-sections or as ordered by the Engineer. The work of formation of subgrade shall be performed at this plane.

Where precast concrete barrier curb or curbing is to be permanently installed, the work of formation of subgrade shall be performed on the area under the precast concrete barrier curb or curbing.

Where shoulders are to be reconstructed and the existing subbase is to remain, the work of formation of subgrade shall be performed at the plane coincident with the surface of the existing subbase.

After all grading has been substantially completed and all drains laid, the subgrade shall be brought to the lines, grades and cross-sections shown on the plans.

When no item for "Clearing and Grubbing" and no grading items appear in the proposal, the work of clearing waterways, ditches, drainage structures and culverts, as described in 2.01.03, shall be performed as part of this work.

2.09.03—Construction Methods: All soft and yielding material and other portions of the subgrade which will not compact readily shall be removed and replaced with suitable material.

In cut areas, the surface shall be uniformly compacted by use of equipment specifically manufactured for that purpose. Rollers shall deliver a ground pressure of not less than 300 lb./inch of contact width and weigh not less than 10 tons. Vibratory units shall have a static weight of not less than 4 tons. The amount of compactive effort shall be as directed by the Engineer, but shall be at least 4 complete passes of the compacting equipment being used.

The maximum dry density after compaction shall be as specified in 2.02.03-6.

Where multiple compacting units are to be used, that unit which exerts the larger compactive effort shall make the initial passes. Any portion of the subgrade not accessible to larger compacting units shall be compacted, as directed by the Engineer, to a degree equal to that obtained on the other portions of the subgrade with equipment and by methods appropriate to the size of the inaccessible area.

After compacting, the subgrade shall be true to required line and grade. There will be no direct payment for any materials required to bring the subgrade to the line, grade and cross-section shown on the plans.

The Contractor shall protect the completed subgrade from damage by exercising such precautions as the Engineer deems necessary. The subgrade surface shall be maintained in such condition as to permit proper drainage. It shall be checked and approved by the Engineer prior to placing any pavement structure and shoulders thereon.

2.09.04—Method of Measurement: Payment lines for formation of subgrade shall be coincident with the outside edges of the pavement or where paved shoulders are constructed, with the outside edges of the shoulder. Where precast concrete barrier curb is permanently installed, payment shall include the area under the precast concrete barrier curb. Payment for formation of subgrade will be allowed when such work is done in providing connections to public roads. Payment for formation of subgrade will not be allowed for work at private drives, in areas where traffic bound gravel is constructed or in areas where existing pavement is used as a base for resurfacing with bituminous concrete.

The area computed for payment shall not include the area of any bridge floor where the type of construction is such as to eliminate any necessity for the work described herein.

2.09.05—Basis of Payment: Formation and protection of subgrade, including all work provided for hereinbefore, will be paid for at the Contract unit price per square yard for "Formation of Subgrade," which price shall include all materials, equipment, tools, compaction testing and labor necessary thereto.

There will be no specific payment for the work of scarifying existing stone or gravel roads as described in 2.02.03, but the cost of such work shall be considered included in the payment for the item providing for the formation of subgrade.

When no item for "Formation of Subgrade" appears in the proposal, the cost of this work shall be included in the Contract unit price for the pavement item or items involved.

Pay Item	Pay Unit
Formation of Subgrade	s.y.

SECTION 2.12
SUBBASE

2.12.01—Description: The subbase shall consist of a clean soil-aggregate mixture of bank or crushed gravel, crusher run stone, reclaimed miscellaneous aggregate containing no more than 2% by weight of asphalt cement or any combinations thereof, placed where shown on the plans or where directed by the Engineer and constructed in accordance with these specifications.

2.12.02—Materials: All materials for this work shall conform to the requirements of M.02.02 and M.02.06.

2.12.03—Construction Methods: The prepared foundation for the subbase shall be carefully shaped to the required cross-section and compacted. Where underdrains and outlets are specified on the plans or ordered by the Engineer, they shall be in place and functioning before any subbase material is placed.

The subbase material shall be spread uniformly upon the required grade, in courses not to exceed 6 inches thick after final compaction. However, if the required thickness of subbase does not exceed 8 inches it may be placed in a single course.

After each course has been placed as specified above, its entire area shall be compacted with equipment specifically manufactured for that purpose. The use of hauling and spreading equipment shall not be considered as a substitute for compacting equipment. Compaction shall be continued until the entire course is uniformly compacted to the required minimum density. The dry density after compaction shall not be less than 95% of the maximum dry density for that subbase material when determined by the Contractor in accordance with AASHTO T 180 and measured in-place with ASTM D6938 or other methods approved by the Engineer. If a subbase course is formed from reclaimed miscellaneous aggregate containing bituminous concrete, the wet density after compaction on this course shall not be less than 95% of the maximum wet density for that subbase when determined by the Contractor in accordance with AASHTO T 180 and measured in-place with ASTM D6938 or other methods approved by the Engineer.

The Contractor shall perform in-place density testing at a sufficient frequency to ensure that the specified results are continuously met. The Contractor shall submit complete field density testing and inspection records to the Engineer within 48 hours (excluding weekends and holidays) of the test in a manner acceptable to the Engineer.

Should the foundation material beneath the subbase become churned up and mixed with subbase material at any time, the Contractor shall, without additional compensation, remove the mixture and replace it with new subbase material to the required thickness shown on the plans or as previously required by the Engineer. Such replaced subbase material shall be compacted to the required minimum density.

2.12.04—Method of Measurement: Subbase will be measured horizontally in place after final grading and compaction. The thickness will be as indicated on the plans, or as ordered by the Engineer, and within the following tolerances:

Less than 24 inches: minus 1 inch to plus 3/4 inch
24 inches and greater: minus 2 inches to plus 1 inch

Measurements to determine the thickness will be made by the Engineer at intervals of 500 feet, or less, along lanes and shall be considered as representative of the lane. For purposes of these measurements, a shoulder will be considered a lane.

If deficient thicknesses are found, the Engineer will make such additional measurements considered necessary to determine the longitudinal limits of the deficiency. Areas not within allowable tolerances shall be corrected, as ordered by the Engineer, without additional compensation to the Contractor.

2.12.05—Basis of Payment: This work will be paid at the Contract unit price per cubic yard for "Subbase," which price shall include all materials, equipment, tools, compaction testing and labor incidental thereto.

Pay Item	Pay Unit
Subbase	c.y.

SECTION 2.13
GRANULAR FILL

2.13.01—Description: This material shall be used as a foundation for structures, to replace unstable material in slopes, as a foundation for sidewalks and culverts, in shoulders and elsewhere as indicated on the plans, required by the specifications or ordered by the Engineer. It shall consist of gravel or reclaimed miscellaneous aggregate containing no more than 2% by weight of asphalt cement meeting the requirements of these specifications.

2.13.02—Materials: Granular fill shall meet the requirements of M.02.01

2.13.03—Construction Methods: When granular fill is used for foundation for structures or to replace rock or unsuitable material in trenches, it shall be deposited in layers not over 6 inches deep, with each layer thoroughly compacted before the addition of other layers.

2.13.04—Method of Measurement: Granular fill will be measured in place after compaction within the payment lines shown or specified by the Engineer.

2.13.05—Basis of Payment: This work will be paid for at the Contract unit price per cubic yard for "Granular Fill," complete in place, which price shall include all materials, tools, equipment and labor incidental thereto.

Pay Item	Pay Unit
Granular Fill	c.y.

SECTION 2.14
COMPACTED GRANULAR FILL

2.14.01—Description: Work under this item shall consist of furnishing and placing compacted granular fill as foundation for structures where shown on the plans or directed by the Engineer.

2.14.02—Materials: Gravel or reclaimed miscellaneous aggregate shall meet the requirements of M.02.02. Admixtures and surface protective materials used to prevent the gravel from freezing must meet the approval of the Engineer.

2.14.03—Construction Methods: After all excavation has been completed, gravel or reclaimed miscellaneous aggregate shall be deposited in layers not exceeding 8 inches deep over the areas. In exceptional cases, the Engineer may permit the first layer to be thicker than 8 inches. Each layer shall be leveled off by the use of blade graders or bulldozers with adequate power for the work involved. The entire area of each layer shall be compacted by use of vibratory, pneumatic tire or tread type compaction equipment approved by the Engineer. The compaction shall be continued until the dry density over the entire area of each layer is not less than 95% of the maximum dry density for that material when determined by the Contractor in accordance with AASHTO T 180 and measured in-place with ASTM D6938 or other methods approved by the Engineer.

If a layer is formed from reclaimed miscellaneous aggregate containing bituminous concrete, the wet density after compaction on this layer shall not be less than 95% of the maximum wet density for that compacted granular fill when determined by the Contractor in accordance with AASHTO T 180 and measured in-place with ASTM D6938 or other methods approved by the Engineer.

The Contractor shall perform in-place density testing at a sufficient frequency to ensure that the specified results are continuously met. The Contractor shall submit complete field density testing and inspection records to the Engineer within 48 hours (excluding weekends and holidays) of the test in a manner acceptable to the Engineer.

The embankment adjacent to the compacted granular fill shall be placed simultaneously with the compacted granular fill, and at no time shall there be a difference of more than 2 feet in elevation between the classes of material. The embankment material to be placed simultaneously with the compacted granular fill shall extend at least 20 feet in every direction beyond the limits of the compacted granular fill, except that where a narrower width is shown on the plans, such narrower width of material shall be placed as prescribed above.

2.14.04—Method of Measurement: Compacted granular fill will be measured in place after compaction, by the average end area method, or by a method approved by the Engineer.

2.14.05—Basis of Payment: This work will be paid for at the Contract unit price per cubic yard for "Compacted Granular Fill," complete in place, which price shall include all materials, equipment, tools, compaction testing and labor incidental thereto.

The cost of water and work involved in puddling, admixtures and protective materials shall be included in the Contract unit price per cubic yard for "Compacted Granular Fill."

Pay Item	Pay Unit
Compacted Granular Fill	c.y.

SECTION 2.16
PERVIOUS STRUCTURE BACKFILL

2.16.01—Description: Pervious structure backfill shall include the furnishing, placing, and compaction of pervious material adjacent to structures. This item shall also consist of furnishing and placing crushed stone or gravel in permeable material bags at the inlet ends of weep holes in structures to the dimensions indicated on the plans or as ordered by the Engineer.

2.16.02—Materials: Pervious structure backfill shall meet the requirements of M.02.05.

The materials for bagged stone shall meet the following requirements:

1. The crushed stone or gravel shall meet the gradation requirements specified in Table M.01.02-2 for No. 3 or No. 4 coarse aggregate or a combination of both.
2. The bag shall be of permeable material sized to contain 1 c.f. of loosely packed granular material.

2.16.03—Construction Methods: Pervious structure backfill shall be placed adjacent to abutments, retaining walls, box culverts, and elsewhere as called for. It shall be placed above a plane extending on a 2 to 1 slope from the upper edge of the footing to the top of the embankment, or as shown on the plans. Where the face of undisturbed material is above or beneath this slope plane, the amount of pervious structure backfill shall be decreased or increased accordingly, if ordered by the Engineer.

In filling behind abutments, retaining walls, box culverts, or other structures, the fill is placed against undisturbed material, or against compacted embankments having a length in a direction at right angles to the abutment wall or culvert not less than twice the height of the structure against which the fill is placed. The slope of the embankment on which the pervious structure backfill is to be placed shall be plowed deeply or cut into steps before and during the placing of pervious structure backfill so both types of material will be thoroughly bonded and compacted.

Each layer of pervious structure backfill shall be spread to a thickness not exceeding 6 inches deep after compaction and shall be thoroughly compacted as directed by the Engineer by the use of power rollers or other motorized vehicular equipment, by tamping with mechanical rammers or vibrators, or by pneumatic tampers. Any equipment not principally manufactured for compaction purposes and equipment which is not in proper working order in all respects shall not be used within the area described above.

Special attention shall be given to compaction in places close to walls where motorized vehicular equipment cannot reach. Within 3 feet of the back face of walls and within a greater distance at angle points of walls, each layer of pervious structure backfill shall be compacted by mechanical rammers, vibrators, or pneumatic tampers.

The dry density of each layer of pervious structure backfill formed from broken or crushed stone, broken or crushed gravel or reclaimed miscellaneous aggregate free of bituminous concrete shall have a dry density after compaction that is not less than 98% of the maximum dry density for that material when determined by the Contractor in accordance with AASHTO T 180 and measured in-place with ASTM D6938 or other methods approved by the Engineer.

If a layer formed from reclaimed miscellaneous aggregate containing bituminous concrete is placed as pervious structure backfill, the wet density of this layer after compaction shall not be less than 98% of the maximum wet density for that material when determined by the Contractor in accordance with AASHTO T180 and measured in-place with ASTM D6938 or other methods approved by the Engineer.

The Contractor shall perform in-place density testing at a sufficient frequency to ensure that the specified results are continuously met. The Contractor shall submit complete field density testing and inspection records to the Engineer within 48 hours (excluding weekends and holidays) of the test in a manner acceptable to the Engineer.

Where weep holes are installed, bagged stone shall be placed around the inlet end of each weep hole, to prevent movement of the pervious material into the weep hole. Approximately 1 c.f. of crushed stone or gravel shall be enclosed in each of the permeable material bags. All bags shall then be securely tied at the neck with cord or wire so that the enclosed material is contained loosely. The filled bags shall be stacked at the weep holes to the dimensions shown on the plans or as directed by the Engineer. The bags shall be unbroken at the time pervious material is placed around them, and bags which are broken or burst prior to or during the placing of the pervious material shall be replaced at the Contractor's expense.

2.16.04—Method of Measurement: Payment lines for pervious structure backfill shall coincide with the limits of the compacted pervious structure backfill as actually placed and ordered by the Engineer.

2.16.05—Basis of Payment: Pervious structure backfill will be paid for the Contract unit price per cubic yard for "Pervious Structure Backfill," complete in place and the price shall include compaction testing.

There will be no direct payment for bagged stone, but the cost thereof shall be included in the cost of the work for “Pervious Structure Backfill.”

Pay Item	Pay Unit
Pervious Structure Backfill	c.y.

SECTION 3.04
PROCESSED AGGREGATE BASE

3.04.01—Description: The base shall consist of a foundation constructed on the prepared subbase or subgrade in accordance with these specifications and in accordance with the lines, grades, compacted thickness and typical cross-section as shown on the plans.

3.04.02—Materials: All materials for this work shall meet the requirements of M.05.01.

3.04.03—Construction Methods: The same type of coarse aggregate shall be used throughout a Project unless otherwise permitted by the Engineer.

Prior to placing the processed aggregate base, the prepared subbase or subgrade shall be maintained true to line and grade, for a minimum distance of 200 feet in advance of the work. None of the aggregate courses shall be placed more than 500 feet ahead of the compaction and binding operation on that particular course.

The processed aggregate base shall be spread uniformly by a method approved by the Engineer. The thickness of each course shall not be more than 4 inches after compaction, unless otherwise ordered.

After the aggregate is spread, it shall be thoroughly compacted and bound by use of equipment specifically manufactured for that purpose. Rollers shall deliver a ground pressure of not less than 300 lb./in of contact width and shall have a weight not less than 10 tons. Vibratory units shall have a static weight of not less than 4 tons. Water may be used during the compaction and binding operation and shall be applied from an approved watering device. The compacting and binding operation shall begin at the outside edges, overlapping the shoulders for a distance of not less than 6 inches and progress towards the middle, parallel with the centerline of the pavement. The work shall cover the entire surface of the course with uniform overlapping of each preceding track or pass. Areas of super-elevation and special cross slope shall be compacted by beginning at the lowest edge and proceeding towards the higher edge, unless otherwise directed by the Engineer. The compacting and binding operation shall be continued until the voids in the aggregates have been reduced to provide a firm and uniform surface satisfactory to the Engineer. The amount of compactive effort shall in no case be less than 4 complete passes of the compacting and binding operations. All aggregate shall be completely compacted and bound at the end of each day's work or when traffic is to be permitted to operate on the road. The dry density of each layer of processed aggregate base after compaction shall not be less than 95% of the maximum dry density for that material when determined by the Contractor in accordance with AASHTO T 180 and measured in-place with ASTM D6938 or other methods approved by the Engineer.

The Contractor shall perform in-place density testing at a sufficient frequency to ensure that the specified results are continuously met. The Contractor shall submit complete field density testing and inspection records to the Engineer within 48 hours (excluding weekends and holidays) of the test in a manner acceptable to the Engineer.

Should the subbase or subgrade material become churned up or mixed with the processed aggregate base at any time, the Contractor shall, without additional compensation remove the mixture. The Contractor shall add new subbase material, if required, and reshape and recompact the subbase in accordance with the requirements of 2.12.03. New aggregate material shall be added, compacted and bound, as hereinbefore specified, to match the surrounding surface.

Any surface irregularities which develop during, or after work on each course, shall be corrected by loosening material already in place and removing or adding aggregate as required. The entire area, including the surrounding surface, shall be re-compacted and rebound until it is brought to a firm and uniform surface satisfactory to the Engineer.

3.04.04—Method of Measurement: Processed Aggregate Base will be measured horizontally in place after final grading and compaction. Materials placed beyond the horizontal limits indicated on the plans will not be measured for payment.

The total thickness shall be as indicated on the plans, or as ordered by the Engineer and within a tolerance of -3/4 inch to +1/2 inch. Measurements to determine the thickness will be taken by the Engineer at

intervals of 500 feet or less, along lanes, and shall be considered representative of the lane. For the purpose of these measurements, a shoulder will be considered a lane.

If a thickness measurement is taken and found deficient, additional measurements considered necessary by the Engineer will be taken to determine the longitudinal limits of the deficiency. Areas not within allowable tolerances shall be corrected, as ordered by the Engineer, without additional compensation to the Contractor.

3.04.05--Basis of Payment: This work will be paid for at the Contract unit price per cubic yard for "Processed Aggregate Base," complete in place, which price shall include all materials, tools, equipment, compaction testing and work incidental thereto.

Pay Item	Pay Unit
Processed Aggregate Base	c.y.

SECTION 3.05
PROCESSED AGGREGATE

3.05.01—Description: Work under this item shall consist of furnishing, placing, shaping and compacting processed aggregate to be used for back-up to bituminous concrete overlays in areas shown on the plans or where directed by the Engineer.

3.05.02—Materials: The material for this item shall meet the requirements of M.05.01, except that coarse aggregate shall be broken stone, and fine aggregate shall be stone sand, screenings, or a combination thereof.

3.05.03—Construction Methods: The material shall be placed, shaped, and compacted in a single continuous operation to the lines, grades, and cross slopes shown on the plans or as directed by the Engineer. Only the amount of material that can be placed, shaped, and compacted during the work shift shall be placed. No excess loose material shall be left along the edge of road.

Compaction will be by vibratory equipment determined to be acceptable to the Engineer prior to the start of the work. No specific percent of compaction is required; however, no loose material shall be evident after completion of compaction as approved by the Engineer.

During the hauling and placing operations, the Contractor shall immediately remove any material dumped or spilled on the shoulders or pavement.

It shall be the Contractor's responsibility to maintain and restore any eroded areas to the required line, grade, and cross slope with approved material and to keep the areas in acceptable condition until the construction work is considered complete by the Engineer.

3.05.04—Method of Measurement: The quantity of processed aggregate to be included for payment will be determined by the net weight, in tons, measured in the hauling vehicles. Scales shall be of a type satisfactory to the Engineer and shall be sealed by the Department of Consumer Protection at the expense of the Contractor, as often as the Engineer may require. When required, weighing shall be done in the presence of a Department representative.

3.05.05—Basis of Payment: This material will be paid for at the Contract unit price per ton for "Processed Aggregate," complete in place, which price shall include all materials, equipment, tools, and labor incidental thereto.

Pay Item	Pay Unit
Processed Aggregate	ton

SECTION 4.06
BITUMINOUS CONCRETE

4.06.01—Description: Work under this Section shall include the production, delivery, placement and compaction of a uniform textured, non-segregated, smooth bituminous concrete pavement to the grade and cross section shown on the plans.

The following terms as used in this specification are defined as:

Bituminous Concrete: A composite material consisting of prescribed amounts of asphalt binder and aggregates. Asphalt binder may also contain additives engineered to modify specific properties and/or behavior of the composite material. References to bituminous concrete apply to all of its forms, such as those identified as hot-mix asphalt (HMA) or polymer-modified asphalt (PMA).

Bituminous Concrete Plant (Plant): A structure where aggregates and asphalt binder are combined in a controlled fashion into a bituminous concrete mixture suitable for forming pavements and other paved surfaces.

Course: A continuous layer (a lift or multiple lifts) of the same bituminous concrete mixture placed as part of the pavement structure.

Density Lot: The total tonnage of all bituminous concrete placed in a single lift which are:

1. PWL density lots = When the project total estimated quantity per mixture is larger than 3,500 tons
2. Simple Average density lots = When the project total estimated quantity per mixture is 3,500 tons or less

Disintegration: Erosion or fragmentation of the pavement surface which can be described as polishing, weathering-oxidizing, scaling, spalling, raveling, or formation of potholes.

Dispute Resolution: A procedure used to resolve conflicts between the Engineer and the Contractor's results that may affect payment.

Extended Season Paving Plan: Required to address operations when ambient temperature or pavement temperature is expected to be less than 50°F.

Hot Mix Asphalt (HMA): A bituminous concrete mixture typically produced at 325°F.

In-Season Paving: Operations when ambient temperature and pavement temperature is 50°F or greater.

Job Mix Formula (JMF): A recommended aggregate gradation and asphalt binder content to achieve the required mixture properties.

Leveling Course: A thin lift of HMA placed at an average consistent thickness, usually about an inch, as indicated on the plans to correct minor variations in the contour of the existing pavement surface.

Lift: An application of a bituminous concrete mixture placed and compacted to a specified thickness in a single paver pass.

Percent Within Limits (PWL): The percentage of the lot falling between the Upper Specification Limit (USL) and the Lower Specification Limit (LSL).

Polymer Modified Asphalt (PMA): A bituminous concrete mixture containing a polymer-modified asphalt binder and using a qualified warm mix technology.
Production Lot: The total tonnage of a bituminous concrete mixture from a single source that may receive an adjustment.
Production Sub Lot: Portion of the production lot typically represented by a single sample.
Quality Assurance (QA): All those planned and systematic actions necessary to provide CTDOT the confidence that a Contractor will perform the work as specified in the Contract.
Quality Control (QC): The sum total of activities performed by the vendor (Producer, Manufacturer, and Contractor) to ensure that a product meets contract specification requirements.
Superpave: A bituminous concrete mix design used in mixtures designated as "S*" Where "S" indicates Superpave and * indicates the sieve related to the nominal maximum aggregate size of the mix.
Segregation: A non-uniform distribution of a bituminous concrete mixture in terms of gradation, temperature, or volumetric properties.
Warm Mix Asphalt (WMA) Technology: A qualified additive or technology that may be used to produce a bituminous concrete at reduced temperatures and/or increase workability of the mixture.
Wedge Course: A lift or multiple lifts of HMA placed at a varying thickness as indicated on the plans to increase or decrease the cross slope of the existing pavement surface.

4.06.02—Materials: All materials shall meet the requirements of M.04.

1. Materials Supply: The bituminous concrete mixture must be from one source of supply and originate from one Plant unless authorized by the Engineer.

2. Recycled Materials: Reclaimed Asphalt Pavement (RAP), Crushed Recycled Container Glass (CRCG), Recycled Asphalt Shingles (RAS), or crumb rubber (CR) from recycled tires may be incorporated in bituminous concrete mixtures in accordance with Project Specifications.

3. Tack Coat: Tack coat used for all applications shall be Non-Tracking Asphalt Tack Coat, meeting the requirements of M.04.01-5. Use of alternate tack coats conforming to Material for Tack Coat requirements may be requested by the Contractor. The request shall be submitted in writing to the Engineer for review prior to use.

4.06.03—Construction Methods

1. Material Documentation: All vendors producing bituminous concrete must have Plants with automated vehicle-weighing scales, storage scales, and material feeds capable of producing a delivery ticket containing the information below.

a. State of Connecticut printed on ticket.
b. Name of Producer, identification of Plant, and specific storage silo if used.
c. Date and time.
d. Mixture Designation, mix type and level. Curb mixtures for machine-placed curbing must state "curb mix only."
e. If WMA Technology is used, "-W" must be listed following the mixture designation.
f. Net weight of mixture loaded into the vehicle. (When RAP and/or RAS is used, the moisture content shall be excluded from mixture net weight.)
g. Gross weight (equal to the net weight plus the tare weight or the loaded scale weight).
h. Tare weight of vehicle (daily scale weight of the empty vehicle).
i. Project number, purchase order number, name of Contractor (if Contractor other than Producer).
j. Vehicle number - unique means of identification of vehicle.
k. For Batch Plants: individual aggregate, recycled materials, and virgin asphalt max/target/min weights when silos are not used.
l. For every mixture designation: the running daily and project total delivered and sequential load number.

The net weight of mixture loaded into the vehicle must be equal to the cumulative measured weights of its components.

The Contractor must notify the Engineer immediately if, during production, there is a malfunction of the weight recording system in the automated Plant. Manually written tickets containing all required information will be allowed for no more than 1 hour.

The State reserves the right to have an Inspector present to monitor batching and/or weighing operations.

2. Transportation of Mixture: The mixture shall be transported in vehicles that are clean of all foreign material, excessive coating or cleaning agents, and that have no gaps through which material might spill.

Any material spilled during the loading or transportation process shall be quantified by re-weighing the vehicle. The Contractor shall load vehicles uniformly so that segregation is minimized. Loaded vehicles shall be tightly covered with waterproof covers acceptable to the Engineer. Mesh covers are prohibited. The cover must minimize air infiltration. Vehicles found not to be in conformance shall not be loaded. Vehicles with loads of bituminous concrete being delivered to State projects must not exceed the statutory or permitted load limits referred to as gross vehicle weight (GVW). The Contractor shall furnish a list and allowable weights of all vehicles transporting mixture. The State reserves the right to check the gross and tare weight of any vehicle. If the gross or tare weight varies from that shown on the delivery ticket by more than 0.4%, the Engineer will recalculate the net weight. The Contractor shall correct the discrepancy to the satisfaction of the Engineer.

If a vehicle delivers mixture to the Project and the delivery ticket indicates that the vehicle is overweight, the load may not be rejected but a "Measured Weight Adjustment" will be taken in accordance with 4.06.04.

Vehicle body coating and cleaning agents must not have a deleterious effect on the mixture. The use of solvents or fuel oil, in any concentration, is prohibited for the coating of vehicle bodies.

For each delivery, the Engineer shall be provided a clear, legible copy of the delivery ticket.

3. Paving Equipment: The Contractor shall have the necessary paving and compaction equipment at the Project Site to perform the work. All equipment shall be in good working order and any equipment that is worn, defective, or inadequate for performance of the work shall be repaired or replaced by the Contractor to the satisfaction of the Engineer. During the paving operation, the use of solvents or fuel oil, in any concentration, is strictly prohibited as a release agent or cleaner on any paving equipment (i.e., rollers, pavers, transfer devices, etc.).

Refueling or cleaning of equipment is prohibited in any location on the Project where fuel or solvents might come in contact with paved areas or areas to be paved. Solvents used in cleaning mechanical equipment or hand tools shall be stored clear of areas paved or to be paved. Before any such equipment and tools are cleaned, they shall be moved off of areas paved or to be paved.

Pavers: Each paver shall have a receiving hopper with sufficient capacity to provide for a uniform spreading operation and a distribution system that places the mix uniformly, without segregation. The paver shall be equipped with and use a vibratory screed system with heaters or burners. The screed system shall be capable of producing a finished surface of the required evenness and texture without tearing, shoving, or gouging the mixture. Pavers with extendible screed units as part of the system shall have auger extensions and tunnel extenders as necessary. Automatic screed controls for grade and slope shall be used at all times unless otherwise authorized by the Engineer. The controls shall automatically adjust the screed to compensate for irregularities in the preceding course or existing base. The controls shall maintain the proper transverse slope and be readily adjustable, and shall operate from a fixed or moving reference such as a grade wire or floating beam (minimum length 20 feet).

Rollers: All rollers shall be self-propelled and designed for compaction of bituminous concrete. Roller types shall include steel wheeled, pneumatic, or a combination thereof. Rollers that operate in a dynamic mode shall have drums that use a vibratory or oscillatory system or combination. Vibratory rollers shall be equipped with indicators for amplitude, frequency, and speed settings/readouts to measure the impacts per foot during the compaction process. Oscillatory rollers shall be equipped with frequency indicators. Rollers can operate in the dynamic mode using the oscillatory system on concrete structures such as bridges and catch basins if at the lowest frequency setting.

Pneumatic tire rollers shall be equipped with wide-tread compaction tires capable of exerting an average contact pressure from 60 to 90 psi uniformly over the surface. The Contractor shall furnish documentation to the Engineer regarding tire size, pressure and loading to confirm that the proper contact pressure is being developed and that the loading and contact pressure are uniform for all wheels.

Tack Distributor Vehicle: The Contractor shall provide a distributor vehicle capable of heating, circulating, and spraying the tack coat at the required application temperature range per the tack manufacturer's recommendations. The spray bar shall maintain a constant height above the pavement and distribute the material in an overlapping spray pattern out of the nozzles to ensure uniform coverage on the surface. The distributor vehicle shall include a tachometer, pressure gauges, and an accurate volume measuring device or a calibrated tank. Volume measuring devices shall meet all applicable state or federal sale requirements.

Lighting for Operations: As needed for paving operations, the Contractor shall provide sufficient artificial lighting to enable the Engineer to thoroughly inspect every phase of the work. The type and number of

lights to be used on each piece of equipment shall be documented by the Contractor in the Project Specific Quality Control Plan. A minimum of 10 foot candle (fc) (or approximately 108 lumens) within a twenty-five-foot radius from millers, pavers, and transfer vehicles shall be provided by the lighting at all times. A minimum of 1 fc (or approximately 11 lumens) within a sixty foot radius from rollers shall be provided at all times. Lighting shall be oriented to minimize glare to passing traffic. The Contractor shall furnish a light meter to the Engineer to verify illumination levels. The light meter shall be capable of measuring light illuminance from LED, Fluorescent, Halogen, and other lights being used at the levels specified with a rated accuracy of ±3% or better.

Material Transfer Vehicle (MTV): A MTV shall be used when placing bituminous concrete surface course (a lift or multiple lifts) as indicated in the Contract except as noted on the plans or as directed by the Engineer. In addition, continuous paving lengths of less than 500 feet may not require the use of a MTV as determined by the Engineer.

The MTV must be a vehicle specifically designed for the purpose of delivering the bituminous concrete mixture from the delivery vehicle to the paver. The MTV must continuously remix the bituminous concrete mixture throughout the placement process.

The use of a MTV will be subject to the requirements stated in 1.07.05 Load Restrictions. The Engineer may limit the use of the vehicle if it is determined that the use of the MTV may damage highway components, utilities, or bridges. The Contractor shall submit to the Engineer at time of pre-construction the following information:

1. The make and model of the MTV.
2. The individual axle weights and axle spacing for each piece of paving equipment (haul vehicle, MTV and paver).
3. A working drawing showing the axle spacing in combination with all pieces of equipment that will comprise the paving echelon.

4. Test Section: The Engineer may require the Contractor to place a test section whenever the requirements of this specification or M.04 are not met.

The Contractor shall submit the quantity of mixture to be placed and the location of the test section for review and approval by the Engineer. The same equipment used in the construction of a passing test section shall be used throughout production.

If a test section fails to meet specifications, the Contractor shall stop production, make necessary adjustments to the job mix formula, Plant operations, or procedures for placement and compaction. The Contractor shall construct test sections, as allowed by the Engineer, until all the required specifications are met. All test sections shall also be subject to removal as set forth in 1.06.04.

5. Transitions for Roadway Surface: Transitions shall be formed at any point on the roadway where the pavement surface deviates, vertically, from the uniform longitudinal profile as specified on the plans. Whether formed by milling or by bituminous concrete mixture, all transition lengths shall meet the criteria below unless otherwise specified.

Permanent Transitions: Defined as any gradual change in pavement elevation that remains as a permanent part of the work. A transition shall be constructed no closer than 75 feet from either side of a bridge expansion joint or parapet. All permanent transitions, leading and trailing ends shall meet the following length requirements:

Posted Speed Limit	Permanent Transition Length Required
> 35 mph	30 feet per inch of elevation change
35 mph or less	15 feet per inch of elevation change

In areas where it is impractical to use the above-described permanent transition lengths, the use of a shorter permanent transition length may be permitted when approved by the Engineer.

Temporary Transitions: Defined as a transition that does not remain a permanent part of the work.

All temporary transitions shall meet the following length requirements:

Posted Speed Limit	Temporary Transition Length Required
> 50 mph	Leading Transition: 15 feet per inch of vertical change (thickness) Trailing Transition: 6 feet per inch of vertical change (thickness)
40, 45 or 50 mph	Leading and Trailing: 4 feet per inch of vertical change (thickness)
35 mph or less	Leading and Trailing: 3 feet per inch of vertical change (thickness)

Note: Any temporary transition to be in place over the winter shutdown period or during extended periods of inactivity (more than 30 calendar days) shall meet the greater than 50 mph requirements shown above.

6. Spreading and Finishing of Mixture: Prior to the placement of the mixture, the underlying subbase and other courses shall be brought to the plan grade and cross section within the allowable tolerance. Subbase material shall be free of standing water prior to placement of the mixture,

Before placing a bituminous concrete lift on an existing pavement surface, a uniform coating of tack coat shall be applied to the underlying pavement surface and on the exposed surface of a wedge joint. Such pavement surfaces shall be clean and dry. Mechanical sweeping or other means acceptable to the Engineer shall be used to clean pavement surfaces.

Tack Coat Application: The Contractor shall protect appurtenances from tracking or splattering of tack coat material. All tack coat material shall be applied by pressurized spray that results in a uniform application rate over the entire surface being paved.

All tack coat material, as defined in M.04, shall be applied at an application rate of 0.04 to 0.06 gal./s.y. for a non-milled surface, and an application rate of 0.06 to 0.08 gal./s.y. for a milled surface.

The Engineer must approve the equipment and the method of measurement prior to use. The tack coat material shall be heated to 160°F ± 10°F and shall not be further diluted.

Tack coat shall be allowed sufficient time to break (cure) prior to any paving equipment or haul vehicles driving on it.

The Contractor may request to omit the tack coat application between bituminous concrete layers that have not been exposed to traffic and are placed during the same work shift. Requests to omit tack coat application on the upper and lower surfaces of a wedge joint will not be considered.

Placement: The mixture shall be placed and compacted to provide a smooth, dense surface with a uniform texture and no segregation at the specified thickness and dimensions indicated in the plans and specifications.

When unforeseen weather conditions prevent further placement of the mixture, the Engineer is not obligated to accept or place the bituminous concrete mixture that is in transit from the Plant.

In advance of paving, traffic control requirements shall be set up, maintained throughout placement, and shall not be removed until all associated work is completed, including quality control, sampling for density testing, and inspection activities.

The Contractor shall supply three infrared thermometers, acceptable to the Engineer, for mix delivery temperature verification by the inspector and quality control personnel. At the beginning of each shift, the Contractor shall verify that the thermometers:

- have a minimum accuracy value of ±1% of reading or ± 2°F, whichever is greater.
- are in agreement within 5°F when measuring ambient, base, and mix temperature.

The Contractor shall include the thermometer verification process in the QCP, as well as the replacement or repair timeframe of a thermometer not meeting the above criteria or not functioning.

The placement temperature range shall be listed in the Quality Control Placement Plan and shall meet the requirements of Table M.04.03-4. Any material that falls outside the specified temperature range as measured by two of the three thermometers may be rejected.

The Contractor shall inspect the newly placed pavement for defects in mixture or placement before rolling is started. Any deviation from standard crown or section shall be immediately remedied by placing additional mixture or removing surplus mixture. Such defects shall be corrected to the satisfaction of the Engineer.

Where it is impracticable due to physical limitations to operate the paving equipment, the Engineer may

permit the use of other methods or equipment. Where hand spreading is permitted, the mixture shall be placed by means of suitable shovels and other tools, and in a uniformly loose layer at a thickness that will result in a completed pavement meeting the designed grade and elevation.

Placement Tolerances: Each lift of bituminous concrete placed at a specified thickness shall meet the following requirements for thickness and area. Any pavement exceeding these limits shall be subject to an adjustment or removal. Lift tolerances will not relieve the Contractor from meeting the final designed grade. Lifts of specified non-uniform thickness, i.e. wedge course, shall not be subject to thickness and area adjustments.

1. Thickness: Where the average thickness of the lift exceeds that shown on the plans beyond the tolerances shown in Table 4.06-3, the Engineer will calculate the thickness adjustment in accordance with 4.06.04.

TABLE 4.06-3: Thickness Tolerances

Mixture Designation	Lift Tolerance
S1	+/- 3/8 inch
S0.25, S0.375, S0.5	+/- 1/4 inch

Where the thickness of the lift of mixture is less than that shown on the plans beyond the tolerances shown in Table 4.06-3, the Contractor, with the approval of the Engineer, shall take corrective action in accordance with this Section.

2. Area: Where the width of the lift exceeds that shown on the plans by more than the specified thickness, the Engineer will calculate the area adjustment in 4.06.04.
3. Delivered Weight of Mixture: When the delivery ticket shows that the truck exceeds the allowable gross weight for the vehicle type, the Engineer will calculate the weight adjustment in accordance with 4.06.04.

Transverse Joints: All transverse joints shall be formed by saw-cutting to expose the full thickness of the lift. Tack coat shall be applied to the sawn face immediately prior to additional mixture being placed.

Compaction: The Contractor shall compact the mixture to meet the density requirements as stated in 4.06.04 for any lift placed with a thickness of 1 1/2 inches or greater, and eliminate all roller marks without displacement, shoving, cracking, or aggregate breakage. This shall include wedge courses when the wedge thickness is 1 1/2 inches or greater within a single paver pass.

When placing a lift with a specified thickness less than 1 1/2 inches the Contractor shall provide a minimum rolling pattern as determined by the development of a compaction curve. This shall include wedge courses when the wedge or any portion of the wedge thickness is less than 1 1/2 inches within a single paver pass. The procedure to be used shall be documented in the Contractor's QCP for placement and demonstrated on the first day of placement.

The use of the vibratory system on concrete structures is prohibited. When approved by the Engineer, the Contractor may operate a roller using an oscillatory system at the lowest frequency setting.

If the Engineer determines that the use of compaction equipment in the dynamic mode may damage highway components, utilities or adjacent property, the Contractor shall provide alternate compaction equipment.

Rollers operating in the dynamic mode shall be shut off when changing directions.

These allowances will not relieve the Contractor from meeting pavement compaction requirements.

Surface Requirements:

Each lift of the surface course shall not vary more than 1/4 inch from a Contractor-supplied 10 foot straightedge. For all other lifts of bituminous concrete, the tolerance shall be 3/8 inch. Such tolerance will apply to all paved areas.

Any surface that exceeds these tolerances shall be corrected by the Contractor at its own expense.

7. Longitudinal Joint Construction Methods: The Contractor shall use Method I - Notched Wedge Joint (see Figure 4.06-1) when constructing longitudinal joints where lift thicknesses are 1 1/2 inches to 3 inches. S1.0 mixtures shall be excluded from using Method I. Method II - Butt Joint (see Figure 4.06-2) shall be used for lifts less than 1 1/2 inches or greater than 3 inches. Each longitudinal joint shall maintain a consistent offset from the centerline of the roadway along its entire length. The difference in elevation between the two faces of any completed longitudinal joint shall not exceed 1/4 inch at any location.

Method I - Notched Wedge Joint:

A notched wedge joint shall be constructed as shown in Figure 4.06-1 using a device that is attached to the paver screed and is capable of independently adjusting the top and bottom vertical notches. The device

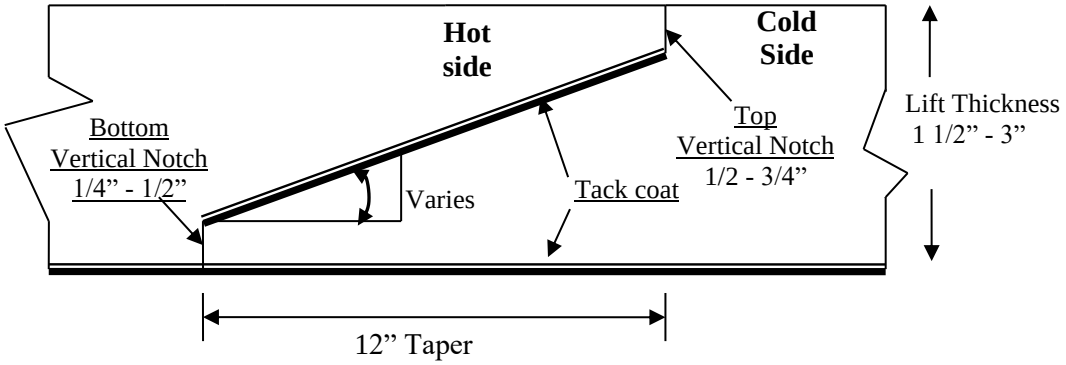
shall have an integrated vibratory system. The top vertical notch must be located at the centerline or lane line or as directed by the Engineer in the final lift. The requirement for paving full width "curb to curb" as described in Method II may be waived if addressed in the QC plan and approved by the Engineer.

The taper portion of the wedge joint shall be evenly compacted using equipment other than the paver or notch wedge joint device. The compaction device shall be the same width as the taper and not reduce the angle of the wedge or ravel the top notch of the joint during compaction.

When placed on paved surfaces, the area below the sloped section of the joint shall be treated with tack coat. The top surface of the sloped section of the joint shall be treated with tack coat prior to placing the completing pass.

The taper portion of the wedge joint shall not be exposed to traffic for more than 5 calendar days.

Figure 4.06-1: Method I, Notched Wedge Joint
(Not to Scale)



Any exposed wedge joint must be located to allow for the free draining of water from the road surface.

The Engineer reserves the right to define the paving limits when using a wedge joint that will be exposed to traffic.

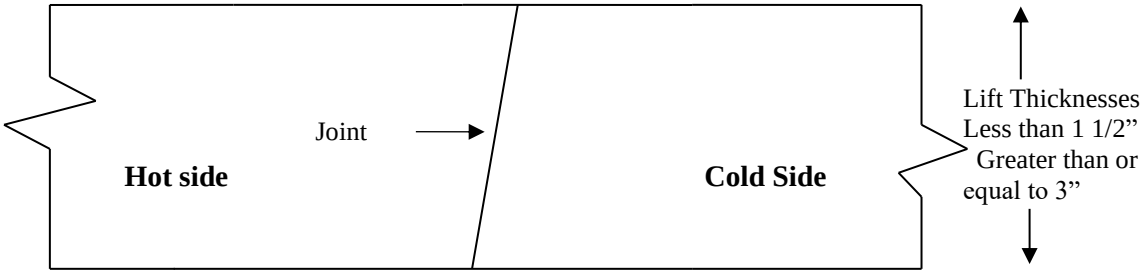
If Method I cannot be used on those lifts which are 1 1/2 inches to 3 inches, Method III may be substituted according to the requirements below for "Method III - Butt Joint with Hot Poured Rubberized Asphalt Treatment."

Method II - Butt Joint:

When adjoining passes are placed, the Contractor shall use the end gate to create a near vertical edge (refer to Figure 4.06-2). The completing pass (hot side) shall have sufficient mixture so that the compacted thickness is not less than the previous pass (cold side). During placement of multiple lifts, the longitudinal joint shall be constructed in such a manner that it is located at least 6 inch from the joint in the lift immediately below. The joint in the final lift shall be at the centerline or at lane lines or as directed by the Engineer. The end gate on the paver should be set so there is an overlap onto the cold side of the joint.

When using this method, the Contractor must complete full width "curb to curb" paving when the vertical edge exposed to traffic would be greater than one inch, unless otherwise allowed by the Engineer.

Figure 4.06-2: Method II, Butt Joint
(Not to Scale)

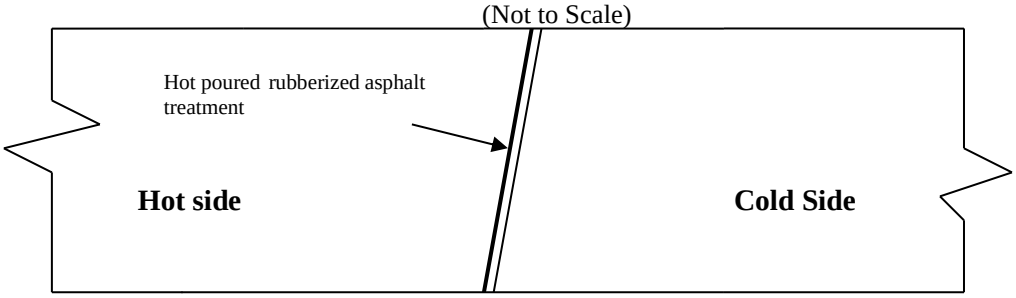


Method III - Butt Joint with Hot Poured Rubberized Asphalt Treatment:

If Method I cannot be used due to physical constraints in certain limited locations, the Contractor may submit a request in writing for approval by the Engineer to use Method III as a substitution in those locations. There shall be no additional measurement or payment made when Method III is substituted for Method I. When required by the Contract or approved by the Engineer, Method III (see Figure 4.06-3) shall be used.

Figure 4.06-3: Method III, Butt Joint with Hot Poured Rubberized Asphalt Treatment

(Not to Scale)



All of the requirements of Method II must be met with Method III. In addition, the longitudinal vertical edge must be treated with a rubberized joint seal material meeting the requirements of ASTM D6690, Type 2. The joint sealant shall be placed on the face of the "cold side" of the butt joint as shown above prior to placing the "hot side" of the butt joint. The joint seal material shall be applied in accordance with the manufacturer's recommendation so as to provide a uniform coverage and avoid excess bleeding onto the newly placed pavement.

8. Contractor Quality Control (QC) Requirements: The Contractor shall be responsible for maintaining adequate quality control procedures throughout the production and placement operations. Therefore, the Contractor must ensure that the materials, mixture, and work provided by Subcontractors, Suppliers, and Producers also meet Contract specification requirements.

This effort must be documented in Quality Control Plans (QCP) and must address the actions, inspection, or sampling and testing necessary to keep the production and placement operations in control, to determine when an operation has gone out of control and to respond to correct the situation in a timely fashion.

The QCP for production shall consist of the quality control program specific to the production facility.

There are 3 components to the QCP for placement: a Standard QCP that is applicable to all projects for the year, a Project Summary Sheet that supplements the standard QCP that details Project-specific information, and, if applicable, a separate Extended Season Paving Plan to address project specific operations expected to occur when ambient temperature or pavement temperature is less than 50°F.

QCPs shall be submitted to the Department for approval each calendar year and at a minimum of 30 days prior to production or placement. The Extended Season QCP shall be submitted no later than October 15, but prior to anticipated ambient temperature below 50°F.

Production or placement shall not occur until all QCP components have been approved by the Engineer.

Each QCP shall include the name and qualifications of a Quality Control Manager (QCM). The QCM shall be responsible for the administration of the QCP, and any modifications that may become necessary.

The QCM shall have the ability to direct all Contractor personnel on the Project during paving operations.

The QCPs shall also include the name and qualifications of any outside testing laboratory performing any QC functions on behalf of the Contractor. The QC Technician performing in-place density testing shall be NETTCP certified as a paving inspector.

Approval of any QCP does not relieve the Contractor of its responsibility to comply with the Project specifications. The Contractor may propose modifications to the QCPs as work progresses and must document the changes in writing prior to resuming operations. These modifications include changes in quality control procedures, equipment, or personnel.

QCP for Production: Refer to M.04.03-1.

QCP for Placement: The Standard QCP, Project Summary Sheet, and Extended Season Paving Plan shall conform to the format provided on the Advisory Team web page.

The Contractor shall perform all quality control sampling and testing, provide inspection, and exercise management control to ensure that bituminous concrete placement conforms to the requirements as outlined in its QCP during all phases of the work. The Contractor shall document these activities for each day of

placement.

The Contractor shall submit complete field density testing and inspection records to the Engineer within 48 hours in a manner acceptable to the Engineer.

The Contractor may obtain one mat core and one joint core per day for process control, provided this process is detailed in the QCP. The results of these process control cores shall not be used to dispute the Department's determinations from the acceptance cores. The Contractor shall submit the location of each process control core to the Engineer for approval prior to taking the core. The core holes shall be filled to the same requirements described in 4.06.03-10.

9. Temperature and Seasonal Requirements: Paving, including placement of temporary pavements, shall be divided into 2 seasons, "In-Season" and "Extended-Season." The following requirements shall apply unless otherwise authorized or directed by the Engineer:

1. Mixtures shall not be placed on subbase material that is frozen. Mixtures or tack coat shall not be placed when the air or pavement surface temperature is 35°F or less.
2. Should paving operations be scheduled during Extended Season temperatures, the Contractor must submit an Extended Season Paving Plan for the Project that addresses minimum delivered mix temperatures that meet the requirements of Table M.04.03-4. The Plan shall also include:
   a. if WMA, PMA, or other additives are being used;
   b. method of determining mix cooling rate after placement along with maximum paver speed;
   c. enhanced rolling patterns;
   d. and the method to balance mixture delivery and placement operations.

Paving during Extended Season shall not commence until the Engineer has approved the plan.

10. Field Density:

1. The Contractor shall obtain cores in accordance with AASHTO R 67 for the determination of mat and longitudinal joint density of bituminous concrete pavements. The Contractor's representative obtaining samples must be a certified NETTCP HMA Paving Inspector, NETTCP HMA Plant Technician, or has successfully completed the HMA Field Sampling Course administered by The Connecticut Advanced Pavement Laboratory (CAP Lab). Within three (3) calendar days of placement, mat and joint cores shall be extracted on each lift with a specified thickness of 1 1/2 inches or more. That time frame may be extended to a maximum of five (5) days due to inclement weather, State holidays or other access restrictions beyond the control of the Contractor. Joint cores shall not be extracted on HMA S1.0 lifts.

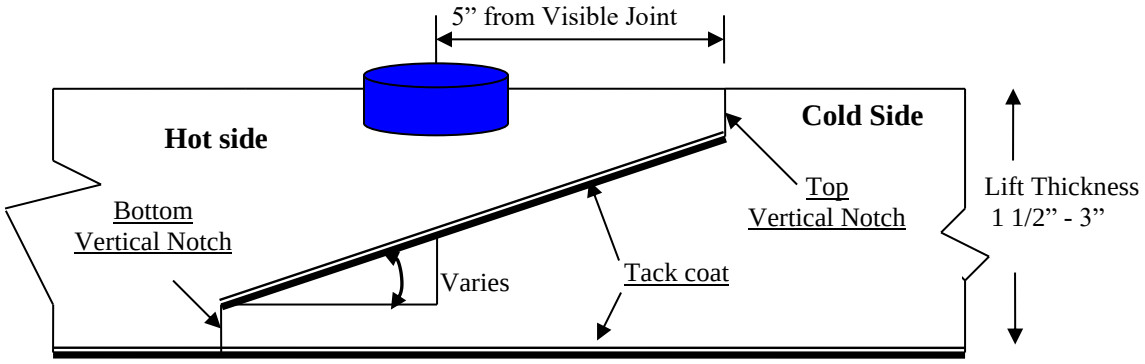
   The Contractor shall extract cores from random locations determined by the Engineer in accordance with ASTM D3665. Six (6) inch diameter cores shall be extracted for all mixes. The number and location of the cores is specified in 4.06.03-10-2 Density Lots. The Contractor shall coordinate with the Engineer to witness the extraction, labeling of cores, and filling of the core holes. The size, shape, and weight of the cores shall not be modified, altered, or manipulated by the Contractor or its representative in any way after extraction from the pavement.

   After the lift has been compacted and cooled, the Contractor shall cut cores to a depth equal to or greater than the lift thickness and shall remove them without damaging the lift(s) to be tested. Any core that is damaged or obviously defective while being obtained will be replaced with a new core from a location within 2 feet measured in a longitudinal direction. The size, shape, and weight of the cores shall not be modified, altered, or manipulated by the Contractor or its representative in any way after extraction from the pavement.

   A mat core shall not be located any closer than 1 foot from the edge of a paver pass. If a random number locates a core less than 1 foot from any edge, the location will be adjusted by the Engineer so that the outer edge of the core is 1 foot from the edge of the paver pass.

   Method I, Notched Wedge Joint cores shall be taken so that the center of the core is 5 inches from the visible joint on the hot mat side (Figure 4.06-4).

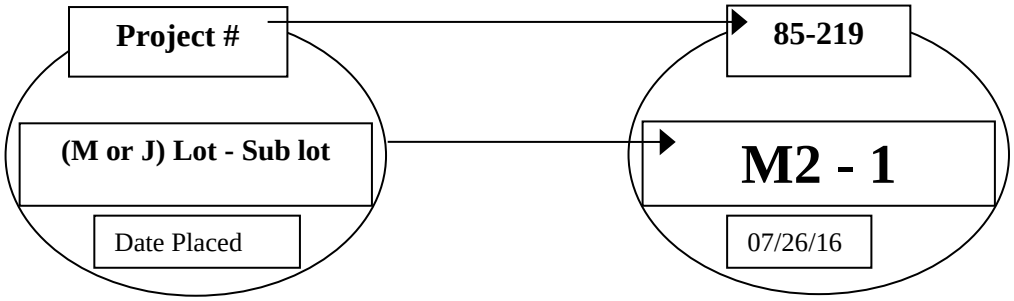
Figure 4.06-4: Notched Wedge Joint Cores (Not to Scale)



When Method II or Method III Butt Joint is used, cores shall be taken from the hot side so the edge of the core is within 1 inch of the longitudinal joint.

The cores shall be labeled by the Contractor with the Project number, date placed, lot number, and sub-lot number. The core's label shall include "M" for a mat core and "J" for a joint core. For example, a mat core from the first lot and the first sub-lot shall be labeled with "M1 – 1." A mat core from the second lot and first sub-lot shall be labeled "M2-1" (see Figure 4.06-5). The Engineer will fill out a MAT-109 to accompany the cores. The Contractor shall deliver the cores and MAT-109 to the Department's Central Lab. The Contractor shall use a container approved by the Engineer. The container shall have a lid capable of being locked shut and tamper proof. The Contractor shall use foam, bubble wrap, or another suitable material to prevent the cores from being damaged during handling and transportation. Once the cores and MAT-109 are in the container the Engineer will secure the lid using security seals at the removable hinges(s) and at the lid opening(s). The security seals' identification number must be documented on the MAT-109. All sealed containers shall be delivered to the Department's Central Lab within two working days from time of extraction. Central Lab personnel will break the security seal and take possession of the cores.

Figure 4.06-5: Labeling of Cores



Each core hole shall be filled within 4 hours upon core extraction. Prior to being filled, the hole shall be prepared by removing any free water and applying tack coat using a brush or other means to uniformly cover the cut surface. The core hole shall be filled using a bituminous concrete mixture at a minimum temperature of 240°F containing the same or smaller nominal maximum aggregate size and compacted with a hand compactor or other mechanical means to the maximum compaction possible. The bituminous concrete shall be compacted to 1/8 inch above the finished pavement.

2. Density Lots

a. *Simple Average*:

A standard simple average density lot evaluated using the Simple Average method is the quantity of material placed in a single lift within a defined area excluding any bridge decks less than 3500 tons. For total individual mix quantities estimated on the project below 2,000 tons, the lot will include all the material between the curb lines. For total individual mix quantities estimated on the project between 2,000 and 3,500 tons, the lift will be evaluated as two lots each consisting of half of the total tonnage of material placed between the curb lines.

A combo simple average density lot is the quantity of material placed within a defined area including bridge decks that are less than or equal to 500 feet long.

A bridge simple average density lot is the quantity of material placed on a bridge deck longer than 500 feet.

Bridge density lots will always be analyzed as using the simple average lot methodology. The number of cores per lot shall be determined in accordance with Table 4.06-5. Multiple bridge decks can be combined into one lot if the paving and underlying conditions are comparable. If multiple bridge decks are combined into a single bridge lot, at least one mat and joint core shall be obtained on each bridge.

The number of cores per lot shall be determined in accordance with Table 4.06-4. For combo lots, if a randomly located mat or joint core location is on a bridge deck, the core is to be obtained on the bridge deck in addition to the core(s) required on the bridge deck.

The number of cores per lot shall be determined in accordance with Table 4.06-5. Multiple bridge decks can be combined into one lot if the paving and underlying conditions are comparable. If multiple bridge decks are combined into a single bridge lot, at least one mat and joint core shall be obtained on each bridge.

The longitudinal locations of mat cores within a standard, combo, or bridge lot containing multiple paving passes will be determined using the combined length of the paving passes within the lot.

TABLE 4.06-4: Number of Cores per Lot (Simple Average)

Lot Type	No. of Mat Cores		No. of Joint Cores	
Standard Lot < 500 Tons	3		3	
Standard Lot ≥ 500 Tons	4		4	
Combo Lot < 500 Tons	2 plus	1 per bridge (≤ 300')	2 plus	1 per bridge (≤ 300)
Combo Lot ≥ 500 Tons[1]	4 plus	2 per bridge (301' – 500')	4 plus	2 per bridge (301' – 500')

TABLE 4.06-5: Number of Core per Bridge Density Lot (Simple Average)

Length of Bridge(s) (Feet)	Minimum No. of Mat Cores	Minimum No. of Joint Cores
< 500	2	2
501 – 1,500	3	3
1,501 – 2,500	4	4
2,501 and greater	5	5

b. *PWL Density Lots*:

When total individual mix quantity estimated on the Project is 3,500 tons or more, the lot shall be evaluated by PWL method.

A PWL mat density lot is 3,500 tons of material placed within 30 calendar days excluding any bridges. One randomly located mat core will be obtained per every 500 tons sublot. Should the final sublot be less than 500 tons, a randomly located mat core is still required.

A PWL joint density lot consists of seven sublots defined by the linear feet of longitudinal joint excluding any joints on bridge decks. One randomly located joint core shall be obtained per every 1,500 lineal feet when a lot includes one longitudinal joint. One randomly located joint core shall be obtained per every 2,000 linear feet of joint when a lot includes two or more longitudinal joints.

A partial PWL mat or joint lot is a lot with four to six samples due to completion of the course, or spanning past 30 calendar days.

11. Acceptance Sampling and Testing: Sampling shall be performed in accordance with ASTM D3665 or a statistically-based procedure of stratified random sampling approved by the Engineer.

Plant Material Acceptance: The Contractor shall provide the required sampling and testing during all phases of the work in accordance with M.04. The Department will verify the Contractor's acceptance test results. Should any test results exceed the specified tolerances in the Department's current QA Program for

Materials, the Contractor's test results for a subject lot or sub lot may be replaced with the Department's results for the purpose of calculating adjustments. The verification procedure is included in the Department's current QA Program for Materials.

Density Acceptance: The Engineer will perform all acceptance testing in accordance with AASHTO T 331. Test specimens will be prepared from the cores by the Engineer. The density of each specimen will be determined using the daily production's average maximum theoretical specific gravity (Gmm) established during the testing of the parent material at the Plant. When there was no testing of the parent material or any Gmm exceeds the specified tolerances in the Department's current QA Program for Materials, the Engineer will determine the maximum theoretical density value to be used for density calculations.

12. Density Dispute Resolution Process: The Contractor and Engineer will work in partnership to avoid potential conflicts and to resolve any differences that may arise during quality control or acceptance testing for density. Both parties will review their sampling and testing procedures and results and share their findings. If the Contractor disputes the Engineer's test results, the Contractor must submit in writing a request to initiate the Dispute Resolution Process within five calendar days of the notification of the test results. No request for dispute resolution will be allowed unless the Contractor provides quality control results from samples taken prior to and after finish rolling, and within the timeframe described in 4.06.03-8 supporting its position. No request for dispute resolution will be allowed for a density lot in which any core was not taken in accordance with 4.06.03-10. Should the dispute not be resolved through evaluation of existing testing data or procedures, the Engineer may authorize the Contractor to obtain a new core or set of core samples per disputed lot. The core samples must be extracted no later than 7 calendar days from the date of the Engineer's authorization. All such core samples shall be extracted and the core hole filled using the procedure outlined in 4.06.03-10.

(a) Simple Average Lots: The Contractor may only dispute any simple average lot that is adjusted at or below 95 percent payment. The number and location (mat, joint, or structure) of the cores taken for dispute resolution must reflect the number and location of the original cores. The location of each core shall be randomly located within the respective original sub lot. The dispute resolution results shall be combined with the original results and averaged for determining the final in-place density value.

(b) PWL Lots: The Contractor may dispute any PWL sublot when the PWL falls below 50% calculated in accordance with 4.06.04-2b. An additional random core in the sublot may be taken to validate the accuracy of the core in question. The Department will verify the additional core test result and may average the original test result with the additional core result for purpose of calculating adjustments.

13. Corrective Work Procedure:

If pavement placed by the Contractor does not meet the specifications, and the Engineer requires its replacement or correction, the Contractor shall:

(a) Propose a corrective procedure to the Engineer for review and approval prior to any corrective work commencing. The proposal shall include:
- Limits of pavement to be replaced or corrected, indicating stationing or other landmarks that are readily distinguishable.
- Proposed work schedule.
- Construction method and sequence of operations.
- Methods of maintenance and protection of traffic.
- Material sources.
- Names and telephone numbers of supervising personnel.

(b) Any corrective courses placed as the final wearing surface shall match the specified lift thickness after completion.

14. Protection of the Work: The Contractor shall protect all sections of the newly finished pavement from damage that may occur as a result of the Contractor's operations for the duration of the Project.

15. Cut Bituminous Concrete Pavement: Work under this item shall consist of making a straight-line cut in the bituminous concrete pavement to the lines delineated on the plans or as directed by the Engineer. The cut shall provide a straight, clean, vertical face with no cracking, tearing or breakage along the cut edge.

4.06.04—Method of Measurement:

1. HMA S* or PMA S*: Bituminous concrete will be measured for payment as the amount of material in tons placed as determined by the net weight on the delivered tickets and adjusted by area, thickness and

weight as follows:

Quantity Adjustments**:** Adjustments may be applied to the placed bituminous concrete quantities that will be measured for payment using the following formulas:

Yield Factor for Adjustment Calculation = 0.0575 tons/SY/inch

Actual Area (SY) = [(Measured Length (ft)) × (Avg. of width measurements (ft))]÷9 s.f./SY

Actual Thickness (t) = Total tons delivered / [Actual Area (SY) × 0.0575 tons/SY/inch]

(a) Area: If the average width exceeds the allowable tolerance, an adjustment will be made using the following formula. The tolerance for width is equal to the specified thickness (inch) of the lift being placed.

Quantity Adjusted for Area (T_A) = [(L × W_{adj})/9] × (t) × 0.0575 Tons/SY/inch = (-) tons

Where: L = Length (ft)
(t) = Actual thickness (inches)
W_{adj} = (Designed width (ft) + tolerance /12) - Measured Width)

(b) Thickness: If the actual average thickness is less than the allowable tolerance, the Contractor shall submit a repair procedure to the Engineer for approval. If the actual thickness exceeds the allowable tolerance, an adjustment will be made using the following formula:

Quantity Adjusted for Thickness (T_T) = A × t_{adj} × 0.0575 = (-) tons

Where: A = Area = {[L × (Design width + tolerance (lift thickness)/12)] / 9}
t_{adj} = Adjusted thickness = [(Dt + tolerance) - Actual thickness]
Dt = Designed thickness (inches)

(c) Weight: If the quantity of bituminous concrete representing the mixture delivered to the Project is in excess of the allowable gross vehicle weight (GVW) for each vehicle, an adjustment will be made using the following formula:

Quantity Adjusted for Weight (T_W) = GVW – DGW= (-) tons

Where: DGW = Delivered gross weight as shown on the delivery ticket or measured on a certified scale

2. Bituminous Concrete Adjustment Cost:

(a) Production Lot Adjustment: An adjustment may be applied to each production lot as follows:

i. Non-PWL Production Lot (less than 3,500 tons):
The adjustment values in Tables 4.06-6 and 4.06-7 will be calculated for each sub lot based on the Air Void (AV) and Asphalt Binder Content (PB) test results for that sub lot. The total adjustment for each day's production (lot) will be computed as follows:

Tons Adjusted for Superpave Design (T_{SD}) = [($AdjAV_t$ + $AdjPB_t$) / 100] × Tons

Where: $AdjAV_t$: Percent adjustment for air voids
$AdjPB_t$: Percent adjustment for asphalt binder
Tons: Weight of material (tons) in the lot adjusted by 4.06.04-1

Percent Adjustment for Air Voids = $AdjAV_t$ = [$AdjAV_1$ + $AdjAV_2$ + $AdjAV_i$ + … + $AdjAV_n$)] /n

Where: $AdjAV_t$ = Total percent air void adjustment value for the lot
$AdjAV_i$ = Adjustment value from Table 4.06-6 resulting from each sub lot or the average of the adjustment values resulting from multiple tests within a sub lot, as approved by the Engineer.
n = number of sub lots based on Table M.04.03-2

TABLE 4.06-6: Adjustment Values for Air Voids

Adjustment Value ($AdjAV_i$) (%)	S0.25, S0.375, S0.5, S1 Air Voids (AV)
+2.5	3.8 - 4.2
+3.125*(AV-3)	3.0 - 3.7
-3.125*(AV-5)	4.3 – 5.0
20*(AV-3)	2.3 – 2.9
-20*(AV-5)	5.1 – 5.7
-20.0	≤ 2.2 or ≥ 5.8

Percent Adjustment for Asphalt Binder = $AdjPB_t = [(AdjPB_1 + AdjPB_2 + AdjPB_i + \ldots + AdjPB_n)] /n$

Where: $AdjPB_t$= Total percent liquid binder adjustment value for the lot
$AdjPB_i$ = Adjustment value from Table 4.06-7 resulting from each sub lot
n = number of binder tests in a production lot

TABLE 4.06-7: Adjustment Values for Binder Content

Adjustment Value ($AdjAV_i$) (%)	S0.25, S0.375, S0.5, S1 Pb
0.0	JMF Pb ± 0.3
- 10.0	≤ JMF Pb - 0.4 or ≥ JMF Pb + 0.4

ii. PWL Production Lot (3500 tons or more):

For each lot, the adjustment values will be calculated using PWL methodology based on AV, VMA, and PB test results. The results will be considered as being normally distributed and all applicable equations in AASHTO R 9 and AASHTO R 42 Appendix X4 will apply.

Only one test result will be considered for each sub lot. The specification limits are listed in M.04.

For AV, PB, and voids in mineral aggregate (VMA), the individual material quantity characteristic adjustment (Adj) will be calculated as follows:

For PWL between 50 and 90%: $Adj(AV_t \text{ or } PB_t \text{ or } VMA_t) = (55 + 0.5\ PWL) - 100$

For PWL at and above 90%: $Adj(AV_t \text{ or } PB_t \text{ or } VMA_t) = (77.5 + 0.25\ PWL) - 100$

Where: $AdjAV_t$ = Total percent AV adjustment value for the lot
$AdjPB_t$= Total percent PB adjustment value for the lot
$AdjVMA_t$= Total percent VMA adjustment value for the lot

A lot with PWL less than 50% in any of the 3 individual material quality characteristics will be evaluated under 1.06.04.

The total adjustment for each production lot will be computed using the following formula:

Tons Adjusted for Superpave Design (T_{SD}) = $[(0.5AdjAV_t + 0.25AdjPB_t + 0.25\ AdjVMA_t) / 100] \times$ Tons

Where : Tons = Weight of material (tons) in the lot adjusted by 4.06.04-1

iii. Partial Lots:

Lots with less than 4 sub lots will be combined with the prior lot. If there is no prior lot with equivalent material or if the last test result of the prior lot is over 30 calendar days old, the adjustment will be calculated as indicated in 4.06.04-2(a)i.

Lots with 4 or more sub lots will be calculated as indicated in 4.06.04-2(a)ii.

Production Lot Adjustment: T_{SD} × Unit Price = Est. (Pi)

Where: Unit Price = Contract unit price per ton per type of mixture
Est. (Pi) = Pay Unit in dollars representing incentive or disincentive per lot

(b) Density Lot Adjustment: An adjustment may be applied to each density lot as follows:

i. Simple Average Density Lot (less than 3500 tons) and Bridge Lots:

The final lot quantity shall be the difference between the total payable tons for the Project and the sum of the previous lots. If either the Mat or Joint adjustment value is “remove and replace,” the density lot shall be removed and replaced (curb to curb).

No positive adjustment will be applied to a density lot in which any core was not taken within the required 5 calendar days of placement.

Tons Adjusted for Density (T_D) = [{(PA_M × 0.50) + (PA_J × 0.50)} / 100] × Tons

Where: T_D = Total tons adjusted for density for each lot
PA_M = Mat density percent adjustment from Table 4.06-8
PA_J = Joint density percent adjustment from Table 4.06-9
Tons: Weight of material (tons) in the lot adjusted by 4.06.04-1

TABLE 4.06-8: Adjustment Values for Pavement Mat density

Average Core Result **Percent Mat Density**	**Percent Adjustment (Bridge and Non-Bridge) [(1)(2)]**
97.1 - 100	-1.667*(ACRPD-98.5)
94.5 – 97.0	+2.5
93.5 – 94.4	+2.5*(ACRPD-93.5)
92.0 – 93.4	0
90.0 – 91.9	-5*(92-ACRPD)
88.0 – 89.9	-10*(91-ACRPD)
87.0 – 87.9	-30
86.9 or less	Remove and Replace (curb to curb)

Notes:
(1) ACRPD = Average Core Result Percent Density
(2) All Percent Adjustments to be rounded to the second decimal place; for example round 1.667 to 1.67

TABLE 4.06-9: Adjustment Values for Pavement Joint Density

Average Core Result **Percent Joint Density**	**Percent Adjustment (Bridge and Non-Bridge) [(1)(2)]**
97.1 – 100	-1.667*(ACRPD-98.5)
93.5 – 97.0	+2.5
92.0 – 93.4	+1.667*(ACRPD-92)
91.0 – 91.9	0
89.0 – 90.9	-7.5*(91-ACRPD)
88.0 – 88.9	-15*(90-ACRPD)
87.0 – 87.9	-30
86.9 or less	Remove and Replace (curb to curb)

Notes:
(1) ACRPD = Average Core Result Percent Density
(2) All Percent Adjustments to be rounded to the second decimal place; for example round 1.667 to 1.67

Additionally, any sublot with a density result below 87% is subject to evaluation under 1.06.04.

ii. PWL Density Lot (3,500 tons or more):
For each lot, the adjustment values will be calculated using PWL methodology based on mat and joint density test results. Only one result will be included for each sublot. The results will be considered as being normally distributed and all applicable equations in AASHTO R 9 and AASHTO R 42 Appendix X4 will apply.
The specification limits for the PWL determination are as follows:
Mat Density: 91.5-98%
Joint Density: 90-98%

For mat and joint density, the individual percent adjustment (PA) will be calculated as follows:
For PWL between 50 and 90%: PA ($_M$ or $_J$)= 0.25 * PWL – 22.50
For PWL at and above 90%: PA ($_M$ or $_J$)= 0.125 * PWL – 11.25
Where: PA_M = Total percent mat density adjustment value for the PWL mat density lot
PA_J= Total percent joint density adjustment value for the PWL joint density lot

No positive adjustment will be applied to a density lot in which any core was not taken within the required 5 calendar days of placement.

A lot with PWL less than 50% will be evaluated under 1.06.04. The total adjustment for each PWL mat density lot will be computed as follows:

Tons Adjusted for Mat Density (T_{MD}) = (PA_M / 100) × Tons
Where: Tons= Weight of material (tons) in the lot adjusted by 4.06.04-1.

The total adjustment for each PWL joint density lot will be computed as follows:

Tons Adjusted for Joint Density (T_{JD}) = (PA_J / 100) × J_Tons
(Tons Adjusted for Joint Density will be calculated at the end of each project or project phase.)
Where: $\text{J\_Tons} = \text{Tons in project or phase adjusted by 4.06.4} - 1 \times \frac{\text{Lot joint length}}{\text{Joint length in project or phase}}$

All bridge density lot adjustments will be evaluated in accordance with 4.06.04-2(b)i.
Additionally, any sublot with a density result below 87% is subject to evaluation under 1.06.04.

iii. Partial Lots:
Lots with less than 4 sub lots will be combined with the prior lot. If there is no prior lot with equivalent material and placement conditions or if the last test result of the prior lot is over 30 calendar days old, the mat and joint individual adjustments will be calculated in accordance to Tables 4.06-8 and 4.06-9. T_{MD} and T_{JD} will be calculated as indicated in 4.06.04-2(b)i.
Lots with 4 or more sub lots will be calculated as indicated in 4.06.04-2(b)ii.

Density Lot Adjustment (Simple Average Lots): T_D × Unit Price = Est. (Di)
Density Lot Adjustment (PWL Lots): (T_{MD} or T_{JD}) × Unit Price = Est. (DMi or DJi)
Where: Unit Price = Contract unit price per ton per type of mixture
Est. (Di)= Pay Unit in dollars representing incentive or disincentive per simple average density lot
Est. (DMi)= Pay Unit in dollars representing incentive or disincentive per PWL mat lot
Est. (DJi)= Pay Unit in dollars representing incentive or disincentive per PWL joint lot

Additionally, any sublot with a density result below 87% is subject to evaluation under 1.06.04.

3. Transitions for Roadway Surface: The installation of permanent transitions will be measured under the appropriate item used in the formation of the transition.

The quantity of material used for the installation of temporary transitions will be measured for payment under the appropriate item used in the formation of the transition. The installation and removal of a bond breaker and the removal and disposal of any temporary transition formed by milling or with bituminous concrete pavement is not measured for payment.

4. Cut Bituminous Concrete Pavement: The quantity of bituminous concrete pavement cut will be measured in accordance with 2.02.04.

5. Non-Tracking Asphalt Tack Coat and **Material for Tack Coat:** The quantity of tack coat will be measured for payment by the number of gallons furnished and applied on the Project and approved by the Engineer. No tack coat material shall be included that is placed in excess of the tolerance described in 4.06.03.

a. Container Method – Material furnished in a container will be measured to the nearest 1/2 gallon. The volume will be determined by either measuring the volume in the original container by a method approved by the Engineer or using a separate graduated container capable of measuring the volume to the nearest 1/2 gallon. The container in which the material is furnished must include the description of material, including lot number or batch number and manufacturer or product source.

b. Vehicle Method
   i. Measured by Weight: The number of gallons furnished will be determined by weighing the material on calibrated scales furnished by the Contractor. To convert weight to gallons, one of the following formulas will be used:
      1. Tack Coat (gallons at 60°F) = Measured Weight (pounds) / Weight per gallon at 60°F
      2. Tack Coat (gallons at 60°F) = 0.996 × Measured Weight (pounds) / Weight per gallon at 77°F
   ii. Measured by automated metering system on the delivery vehicle:
   Tack Coat (gallons at 60°F) = 0.976 × Measured Volume (gallons)

6. Material Transfer Vehicle (MTV): The furnishing and use of a MTV will be measured separately for payment based on the actual number of surface course tons delivered to a paver using the MTV.

4.06.05—Basis of Payment:

1. HMA S* or PMA S*: The furnishing and placing of bituminous concrete will be paid for at the Contract unit price per ton for " HMA S*" or " PMA S*."

All costs associated with providing illumination of the work area are included in the general cost of the work.

All costs associated with cleaning the surface to be paved, including mechanical sweeping, are included in the general cost of the work. All costs associated with constructing longitudinal joints are included in the general cost of the work

All costs associated with obtaining cores for acceptance testing and dispute resolution are included in the general cost of the work.

2. Bituminous Concrete Adjustment Costs: This adjustment will be calculated using the formulas shown below if all of the measured adjustments in 4.06.04-2 are not equal to zero. A positive or negative adjustment will be applied to monies due the Contractor.

Production Lot: Σ Est (Pi) = Est. (P)
Density Lot (Simple Average Lots): Σ Est (Di) = Est. (D)
Density Lot (PWL): Σ Est (DMi) + Σ (DJi) = Est. (D)
Bituminous Concrete Adjustment Cost= Est. (P) + Est. (D)

Where: Est. ( )= Pay Unit in dollars representing incentive or disincentive in each production or density lot calculated in 4.06.04-2

The Bituminous Concrete Adjustment Cost item, if included in the bid proposal or estimate, is not to be altered in any manner by the Bidder. If the Bidder should alter the amount shown, the altered figure will be disregarded and the original estimated cost will be used for the Contract.

3. Transitions for Roadway Surface: The installation of permanent transitions will be paid under the appropriate item used in the formation of the transition. The quantity of material used for the installation of temporary transitions will be paid under the appropriate pay item used in the formation of the transition. The installation and removal of a bond breaker, and the removal and disposal of any temporary transition formed by milling or with bituminous concrete pavement is included in the general cost of the work.

4. The cutting of bituminous concrete pavement will be paid in accordance with 2.02.05.

5. Non-tracking asphalt tack coat will be paid for at the Contract unit price per gallon for "Non-Tracking Asphalt Tack Coat."

6. Material for tack coat will be paid for at the Contract unit price per gallon for "Material for Tack Coat."

7. The Material Transfer Vehicle (MTV) will be paid at the Contract unit price per ton for "Material Transfer Vehicle."

Pay Item	Pay Unit
HMA S*	ton
PMA S*	ton
Bituminous Concrete Adjustment Cost	est.
Non-Tracking Asphalt Tack Coat	gal.
Material for Tack Coat	gal.
Material Transfer Vehicle	ton

SECTION 7.03
RIPRAP

7.03.01—Description: Riprap shall consist of angular shaped stones used to protect foundations of piers, abutments, walls, slopes of embankments and waterways from water damage.

7.03.02—Materials:

1. Stone: The stone for this work shall be the type called for on the plans and shall meet the requirements of M.12.02.

2. Bedding: The bedding material for riprap shall conform to the specifications of the material indicated on the plans.

7.03.03—Construction Methods: The area to be protected by riprap shall be accurately shaped prior to placing of any bedding material or riprap. Where bedding material is called for, it shall be placed on the prepared area and compacted to the depth, lines and grades indicated on the plans.

The riprap shall be placed to its full course thickness in one operation in such a manner as to produce a reasonably well-graded mass of rock without causing displacement of the underlying material. The finished surface shall be free from pockets of small stones and clusters of larger stones. Placing this material by methods likely to cause segregation of the various sizes of stone will not be permitted. Rearranging of individual stones by mechanical or hand methods will be required to the extent necessary to obtain a reasonably well-graded distribution of the specified stone sizes. The completed course shall be of the specified thickness and to the lines and grades as shown on the plans or as ordered by the Engineer.

7.03.04—Method of Measurement: The quantity of riprap measured for payment shall be the number of cubic yards whose length and width is measured in place as accepted and the thickness as shown on the plans.

7.03.05—Basis of Payment: This work will be paid for at the Contract unit price per cubic yard for the type of riprap indicated, complete in place, including all materials, equipment, tools and labor incidental thereto.

Excavation and bedding material will be measured and each paid for under its particular pay item.

Pay Item	Pay Unit
(Type) Riprap	c.y.

SECTION 7.55
GEOTEXTILE

7.55.01—Description: This item shall consist of furnishing and installing geotextile in the locations and to the dimensions shown on the plans as directed or as approved by the Engineer.

7.55.02—Materials: Geotextile shall meet the requirements of M.08.01-19 Geotextiles. Materials incidental to and necessary for the installation of the geotextile, such as sewing thread, anchors, staples, pins, etc., shall meet the requirements of the manufacturer of the geotextile.

7.55.03—Construction Methods: The geotextile shall be installed at the locations and to the dimensions shown on the plans or as directed by the Engineer. Geotextile shall be installed as recommended by the manufacturer and in accordance with the requirements of AASHTO M 288, for the specific use or purpose intended, or as otherwise approved by the Engineer.

1. Separation/Stabilization Geotextiles:
    a. The Site shall be prepared by clearing, grubbing, and excavating or filling the area to the grades shown on the Plans. Soft spots and unsuitable areas shall be excavated and backfilled with suitable material.
    b. The geotextile shall be laid smooth without wrinkles or folds on the prepared subgrade in the direction of construction traffic. Adjacent geotextile rolls shall be overlapped a minimum of 12 inches or joined as required per manufacturer's recommendations.
    c. On curves, the geotextile may be folded or cut to conform to the curves. The fold or overlap shall be in the direction of construction and held in place by pins, staples, or piles of fill or rock.
    d. Prior to covering, the geotextile shall be inspected to ensure that it has not been damaged (i.e., holes, tears, rips) during installation.
    e. Damaged geotextiles as identified by the Engineer shall be repaired with a geotextile patch that extends a minimum of 12 inches beyond the perimeter of the damaged area.
    f. Exposure of geotextiles to the elements following laydown shall be the maximum of the manufacturer's recommendations or 3 calendar days, whichever is less.
    g. Construction vehicles shall not be allowed directly on the geotextile. The material shall be placed by end dumping from the edge of the geotextile, or over previously placed material. Equipment shall not be permitted until at least the minimum specified lift thickness has been compacted. Turning of vehicles shall not be permitted on the first lift above the geotextile.
    h. If damage to geotextile is caused by backfilling, the placement procedures can be modified (i.e., increase initial lift thicknesses, decrease equipment loads, etc.).
    i. In the stabilization applications, the use of vibratory compaction equipment is not recommended with the initial lift of subbase material, as it may cause damage to geotextile.
2. Permanent Erosion Control:
    a. The geotextile shall be placed without wrinkles or folds and anchored on a smooth graded surface approved by the Engineer. Anchoring of both ends of the geotextile shall be with key trenches at the crest and toe of slope as shown on the Plans. To expedite construction, anchoring pins may be placed at 24 to 72 inches on center.
    b. The geotextile shall be placed with the machine direction parallel to the direction of water flow. Adjacent geotextile sheets shall be joined by overlapping a minimum of 12 inches. . Overlaps of adjacent rolls shall be a minimum of 12 inches in all instances.
    c. When overlapping, successive sheets of the geotextile shall be overlapped upstream over downstream, or upslope over downslope.
    d. Should the geotextile be damaged during installation, a geotextile patch shall be placed over the damaged area extending 18 inches beyond the perimeter of the damaged area.
    e. The placement of riprap or revetment system shall begin at the toe and proceed up the slope. Placement shall take place to avoid stretching and subsequent tearing of the geotextile. Riprap and heavy stone fill shall not be dropped from a height of more than 12 inches
    f. Slope protection and smaller sizes of stone shall not be dropped from a height exceeding 40 inches.
    g. Any geotextile damaged during backfill placement shall be repaired or replaced as directed by the Engineer at the Contractor's expense.

7.55.04—Method of Measurement: This work will be measured for payment by the actual number of

square yards of the geotextile installed of the type indicated on the plans or authorized by the Engineer. Geotextile specifically included in the payment of another item will not be measured for payment under this item. No additional measurement will be made for necessary lap material.

7.55.05—Basis of Payment: This work will be paid for at the Contract unit price per square yard of "Geotextile" or "Geotextile (Type)," complete in place, which price shall include all materials, labor, tools, and equipment incidental and necessary for each type of installation and removal where necessary.

Pay Item	Pay Unit
Geotextile	s.y.
Geotextile (Type)	s.y.

SECTION 9.22
BITUMINOUS CONCRETE SIDEWALK
BITUMINOUS CONCRETE DRIVEWAY

9.22.01—Description: This item shall consist of bituminous concrete surfaced sidewalk or driveway constructed on a gravel or reclaimed miscellaneous aggregate base course in the locations and to the dimensions and details shown on the plans or as directed by the Engineer.

9.22.02—Materials: Materials for this work shall meet the following requirements:

1. **Gravel or Reclaimed Miscellaneous Aggregate:** Gravel or reclaimed miscellaneous aggregate for the base course shall meet the requirements of M.02.01 for granular fill.
2. **Bituminous Concrete Surface:** Materials for this surface shall meet the requirements of M.04.

9.22.03—Construction Methods:

1. **Excavation:** Excavation, including saw cutting, removal of any existing sidewalk, or driveway, shall be made to the required depth below the finished grade, as shown on the plans or as directed by the Engineer. All soft and yielding material shall be removed and replaced with suitable material.
2. **Forms:** When the bituminous concrete is spread by hand, forms shall be used. Forms shall be of metal or wood, straight, free from warp and of sufficient strength to resist springing from the impact of the roller. If made of wood, they shall be of 2 inch surfaced plank except that at sharp curves thinner material may be used; if made of metal, they shall be of an approved section. All forms shall be of a depth equal to the depth of the sidewalks or driveways and shall be securely staked, braced, and held firmly to the required line and grade. All forms shall be cleaned and oiled each time they are used.
3. **Base Course:** Gravel or reclaimed miscellaneous aggregate for the base course shall be uniformly spread to the required depth and thoroughly compacted with a roller with a weight of at least 500 pounds.
4. **Bituminous Concrete Surface:** This surface shall be constructed in accordance with the requirements of 4.06, except that the material may be spread by hand and thoroughly compacted by multiple passes of a roller weighing at least 500 pounds.
5. **Backfilling and Removal of Surplus Material:** The sides of the sidewalk or driveway shall be backfilled with suitable material thoroughly compacted and finished flush with the top of the sidewalk or driveway. All surplus material shall be removed and the Site left in a neat and presentable condition to the satisfaction of the Engineer. In sections inaccessible to the roller, the base course, surface course and backfill shall be hand-tamped with tampers weighing not less than 12 pounds, the face of which shall not exceed 50 square inches.

9.22.04—Method of Measurement: This work will be measured for payment as follows:

1. **Bituminous Concrete Driveway—Bituminous Concrete Sidewalk:** This work will be measured by the actual number of square yards of completed and accepted sidewalk or driveway.
2. **Excavation:** Excavation below the finished grade of the sidewalk or driveway, backfilling, and disposal of surplus material will not be measured for payment; but the cost shall be included in the price bid for the sidewalk or driveway. Excavation above the finished grade of the sidewalk or driveway will be classified and paid for in accordance with 2.02.
3. **Gravel or Reclaimed Miscellaneous Aggregate Base:** This work will not be measured for payment but the cost thereof shall be included in the price bid for the sidewalk or driveway.

9.22.05—Basis of Payment: This work will be paid for at the Contract unit price per square yard for "Bituminous Concrete Sidewalk," "Bituminous Concrete Driveway" or "Bituminous Concrete Driveway (Commercial)" as the case may be, complete in place, which price shall include all saw cutting, excavation as specified above, backfill, disposal of surplus material, gravel or reclaimed miscellaneous aggregate base, and all equipment, tools, labor and materials incidental thereto.

Pay Item	Pay Unit
Bituminous Concrete Sidewalk	s.y.
Bituminous Concrete Driveway	s.y.
Bituminous Concrete Driveway (Commercial)	s.y.

SECTION 9.23
BITUMINOUS CONCRETE FOR PATCHING

9.23.01—Description: The work under this item shall consist of the temporary patching of any pavement surfaces or pedestrian passways which have become rutted, broken, damaged or otherwise unserviceable, and at such other locations as the Engineer may designate.

9.23.02—Materials: The materials furnished and used in this work shall meet the requirements of 4.06 and M.04. The specific material to be used for patching shall be as directed by the Engineer.

9.23.03—Construction Methods: Patching shall be done only at the locations and at such time as is deemed necessary by the Engineer. Prior to placing the patching material, the areas to be patched shall be cleaned of dirt and other debris and shall be reasonably dry. Compaction of the patching material shall be attained by methods approved by the Engineer.

9.23.04—Method of Measurement: The quantity of material to be included for payment will be determined by the net weight, in tons, measured in the hauling vehicles furnished by and at the expense of the Contractor. The scales shall be a type satisfactory to the Engineer and shall be sealed. An inspector, to be appointed and compensated by the Department, shall check the weight measurements of all material entering into construction. The total weight will be the summation of the weigh slips of bituminous concrete actually incorporated in the work included under this item.

9.23.05—Basis of Payment: This work will be paid for at the Contract unit price per ton for "Bituminous Concrete for Patching," complete in place, which price shall include furnishing all materials, equipment, tools, labor and work incidental thereto.

Pay Item	Pay Unit
Bituminous Concrete for Patching	ton

DIVISION III
MATERIALS SECTION

SECTION M.01
AGGREGATES

M.01.01—General:

Each source of aggregate must be qualified for use by the Engineer as indicated in 1.06.01.

Material from a qualified source is still subject to Project-level testing and may be subject to rejection as indicated in 1.06.04.

Aggregates must not have expansive or reactive properties. Aggregates reclaimed from pavements or structures may only be used where specifically allowed in the specifications.

Aggregate stockpiles must be located on smooth, hard, sloped/well-drained areas. Each source and gradation of aggregate must have an individual stockpile or bin. Stockpiles must be managed to minimize segregation and contamination with foreign materials.

M.01.02—Coarse Aggregates:

Coarse aggregate must be uniform in consistency and only contain clean, hard, tough, durable fragments meeting the criteria in Table M.01.02-1.

TABLE M.01.02-1: Coarse Aggregate Criteria by Pit/Quarry Source

Item	Title	AASHTO Test Methods	Criteria
1	Material Passing No. 200 Sieve	T 11	1% maximum.
2	Loss on Abrasion	T 96	40% maximum
3	Soundness by Magnesium Sulfate	T 104	10% maximum @ 5 cycles

Standard sizes of coarse aggregate for applications other than bituminous concrete must meet the gradation requirements listed in Table M.01.02-2 as determined by AASHTO T 27.

TABLE M.01.02-2: Gradation of Standard Sizes of Coarse Aggregate

Square Mesh Sieves	Percent Passing by Weight					
	No. 3	No. 4	No. 6	No. 67	No. 8	No. 9
2 1/2 inches	100					
2 inches	90-100	100				
1 1/2 inches	35-70	90-100				
1 inch	0-15	20-55	100	100		
3/4 inch		0-15	90-100	90-100		
1/2 inch	0-5		20-55		100	
3/8 inch		0-5	0-15	20-55	85-100	100
No. 4			0-5	0-10	10-30	85-100
No. 8				0-5	0-10	10-40
No. 16					0-5	0-10
No. 50						0-5

M.01.03—Fine Aggregates:

Fine aggregate must consist of clean, hard, durable, tough, uncoated particles free from lumps, meeting the requirements listed in Table M.01.03-1.

TABLE M.01.03-1: Fine Aggregate Requirements

Item	Property	AASHTO Test	Criteria
1	**Grading**		
	Portland Cement Concrete	T 11	3% maximum passing No. 200 sieve
		T 27	Table M.01.04-1
	Bituminous Concrete	T 27	100% Passing 3/8 inch, 95% passing the No. 4 min.
2	**Absorption**	T 84	3% maximum
3	**Plasticity limits**	T 90	0 or not detectable
4	**L.A. Abrasion**	T 96	50% maximum (fine agg. particle size ≥ No. 8)
5	**Soundness by Magnesium Sulfate**	T 104	15% maximum@ 5 cycles for PC Concrete 20% maximum@ 5 cycles for Bituminous Concrete
6	**Clay Lumps and Friable Particles**	T 112	3% maximum
7	**Deleterious Material** - organic or inorganic calcite, hematite, pyrrohtite, shale, clay, coal-lignite, shells, loam, mica, clinkers, or other organic matter (wood, etc.).	As determined by the Engineer	Must not contain more than 3% by mass of any individual listed constituent and not more than 5% by mass in total of all listed constituents.

Screenings and Dust must meet the requirements of Table M.01.03-2 as determined by AASHTO T 27.

TABLE M.01.03-2: Screenings and Dust Gradation

Square Mesh Sieves	Percent Passing by weight	
	Screenings	Dust
3/8 inch	100	
No. 4		100
No. 8	60-100	40-100

M.01.04—Portland Cement Concrete (PCC) Aggregates:

In addition to the requirements in M.01.01 through M.01.03, the aggregates used in Portland Cement Concrete must meet the following:

All Aggregates: Coarse and Fine aggregates must originate from the aggregate producers and locations included on the Department's Qualified Materials List (QML). The list is available on the Department website. The criteria for inclusion in the QML are stated within the list.

Coarse Aggregate: Coarse aggregate of a size retained on a 1 inch square opening sieve must not contain more than 8% of flat and elongated pieces when tested in accordance to ASTM D4791 at a 1:5 ratio.

Reclaimed concrete aggregates must consist of clean, durable fragments of uniform quality. Materials must be from crushing or otherwise processing of concrete structures or portions thereof. Prior to demolition or removal, concrete structures must not exhibit signs of material degradation and be inspected by the Engineer. Reclaimed aggregate must be tested separately to confirm compliance with all requirements prior to blending with virgin aggregate.

Reclaimed coarse aggregate must not contain chlorides in excess of 0.5 lb./c.y. Chloride content must be determined in accordance with AASHTO T 260, Procedure A. Regardless of chloride content, reclaimed aggregates must not be used in concrete for pre-stressed concrete members.

Fine Aggregate: Manufactured sand must be produced from washed stone screenings; stone screenings or gravel; or combinations thereof, after mechanical screening or with a process approved by the Engineer.

The fineness modulus of fine aggregate from a source must not vary more than 0.20 from the base fineness modulus of that source.

The fine aggregate must not produce a color darker than Gardner Color Standard No. 11 in accordance with AASHTO T 21.

Fine aggregates that fail to meet soundness requirements as specified in Table M.01.03-1, but meet all other requirements, may be used with the approval of the Engineer on a case-by-case basis. Typically concrete composing any surface subject to polishing or abrasion (i.e., wheel traffic or running water) will not be allowed to contain such material.

Gradation of each size aggregate must be within the ranges listed in Table M.01.04-1 as determined by AASHTO T 27.

Table M.01.04-1: Fine Aggregate Gradations

Sieve Size	3/8 inch	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100
% passing	100	95-100	80-100	50-85	25-60	10-30	2-10

M.01.05—Bituminous Concrete Aggregates

In addition to the requirements in M.01.01 through M.01.03, the source of aggregates used in Bituminous Concrete must have a Quality Control Plan for Fine Aggregates (QCPFA) on file with the Engineer. The QCPFA must describe the locations and manufacturing processing methods used at the source. The QCPFA must describe how conformance to Items 1 through 7 in Table M.01.03-1 is monitored and what actions will be taken if nonconformance is observed. The QCPFA must be revised and resubmitted to the Engineer whenever the process, location, or manner of how the fine aggregate is produced or monitored changes. A source of fine aggregate may be suspended by the Engineer due to demonstrated noncompliance with the QCPFA or if consistent production of material does not meet Project specifications as determined by the Engineer.

SECTION M.02
GRANULAR FILL
SUBBASE
GRANULAR BASE AND SURFACES
STONE BASE
PERVIOUS STRUCTURE BACKFILL
FREE-DRAINING MATERIAL
CRUSHER-RUN STONE

M.02.01—Granular Fill: For this purpose, the material shall consist of broken or crushed stone, gravel, reclaimed miscellaneous aggregate or a mixture thereof.

1. **Broken or crushed stone** shall be the product resulting from the artificial crushing of rocks, boulders or large cobblestones, substantially all faces of which have resulted from the crushing operation. Broken or crushed stone shall consist of sound, tough, durable stone, reasonably free from soft, thin, elongated, laminated, friable, micaceous or disintegrated pieces, mud, dirt or other deleterious material and shall be sized to meet the requirements of grading "A," M.02.06.
2. **Bank or crushed gravel** shall consist of sound, tough, durable particles of crushed or uncrushed gravel, free from soft, thin, elongated or laminated pieces and vegetable or other deleterious substances. It shall meet Grading "A" and the requirements for plasticity and resistance to abrasion indicated in M.02.06. Crushed gravel shall be the manufactured product resulting from the deliberate mechanical crushing of gravel with at least 50% of the gravel retained on the No. 4 sieve having at least 1 fractured face.
3. **Reclaimed Miscellaneous Aggregate** material shall consist of sound, tough, durable particles of crushed reclaimed waste. It shall be free of soft disintegrated pieces, mud, dirt, glass or other injurious materials and contain no more than 2% by weight of asphalt cement.

This reclaimed miscellaneous material shall meet Grading "A" and the requirements for plasticity and resistance to abrasion, which are set forth in M.02.06.

Reclaimed Miscellaneous Aggregate shall not be used within a wetland or watercourse.

M.02.02—Subbase: Materials for this work shall conform to the following requirements:

1. **Bank or crushed gravel** shall consist of sound, tough, durable particles of crushed or uncrushed gravel, free from soft, thin, elongated or laminated pieces and vegetable or other deleterious substances. It shall be hard and durable enough to resist weathering, traffic abrasion and crushing. It shall meet Grading "B" and the requirements for plasticity and resistance to abrasion indicated in M.02.06.
2. **Crusher-Run Stone** shall consist of sound, tough, durable broken stone. It shall be reasonably free from soft, thin, elongated, laminated, friable, micaceous or disintegrated pieces, mud, dirt or other deleterious material.

(a) Loss on Abrasion: The crusher-run stone shall show a loss on abrasion of not more than 50% using AASHTO Method T 96.

(b) Grading: The crusher-run stone shall meet Grading "A" and the requirements for plasticity indicated in M.02.06.

3. **Reclaimed Miscellaneous Aggregate** shall consist of sound, tough, durable particles of crushed reclaimed waste. It shall be free from soft, disintegrated pieces, mud, dirt, glass or other injurious material, and contain no more than 2% by weight of asphalt cement.

This reclaimed miscellaneous material shall meet Grading "B" and the requirements for plasticity and resistance to abrasion, which are set forth in M.02.06.

M.02.03—Granular Base, Rolled Bank Gravel Surface and Traffic Bound Gravel Surface: The materials for the "Rolled Granular Base" shall consist of sound, tough, durable particles of bank or crushed gravel, or reclaimed miscellaneous aggregate, or mixtures thereof with the resultant uniform blend containing no more than 2% by weight of asphalt cement. The materials for the Rolled Bank Gravel Surface and Traffic-Bound Gravel Surface shall consist of sound, tough, durable particles of bank or

crushed gravel. All materials shall be free from thin or elongated pieces, lumps of clay, loam, or vegetable matter. Binder may be added and incorporated by approved methods as specified elsewhere. It shall meet Grading "A" except that the top course of the rolled bank gravel surface shall conform to Grading "C."

M.02.04—Gravel Shoulders: The materials for this work shall consist of sound, tough, durable particles of crushed or uncrushed gravel free from soft, thin, elongated or laminated pieces, vegetable or other deleterious substances. Gravel shall meet Grading "A" except that the upper 3 inches shall conform to Grading "C."

M.02.05—Pervious Structure Backfill: Pervious structure backfill shall consist of broken or crushed stone, broken or crushed gravel, or reclaimed miscellaneous aggregate containing no more than 2% by weight of asphalt cement or mixtures thereof.

Materials for this work shall conform to the following requirements:

1. Broken or crushed stone shall consist of sound, tough, durable stone, reasonably free from soft, thin, elongated, friable, laminated, micaceous or disintegrated pieces, mud, dirt or other deleterious material and shall be sized to meet the requirements of Grading "B," M.02.06. It shall meet the requirements of loss on abrasion indicated in M.02.02-2(a).

2. Bank or crushed gravel shall consist of sound, tough, durable particles of crushed or uncrushed gravel free from soft, thin, elongated or laminated pieces and vegetable or other deleterious substances. It shall meet Grading "B."

3. Reclaimed Miscellaneous Aggregate shall consist of sound, tough, durable particles of crushed reclaimed waste. It shall be free of soft disintegrated pieces, mud, dirt, glass or other injurious material, and contain no more than 2% by weight of asphalt cement. It shall meet Grading "B."

M.02.06—Gradation, Plasticity, Resistance to Abrasion and Soundness Requirements:

1. Gradation:

	Grading		
	A	**B**	**C**
Square Mesh Sieves	Percent passing by weight		
Pass 5 inch		100	
Pass 3 1/2 inch	100	90-100	
Pass 1 1/2 inch	55-100	55-95	100
Pass 3/4 inch			45-80
Pass 1/4 inch	25-60	25-60	25-60
Pass No. 10	15-45	15-45	15-45
Pass No. 40	5-25	5-25	5-25
Pass No. 100	0-10	0-10	0-10
Pass No. 200	0-5	0-5	0-5

The grading percentages specified in the above table shall apply to the material after it has been delivered to the construction site as well as when tested at the pit or other source of supply.

When the fraction of the dry sample passing the No. 100 mesh sieve is greater than 8% by weight, the sample will be washed as indicated. The amount obtained from washing shall be added to that obtained by dry sieving; and the total amount passing each sieve shall meet the above gradation.

2. Plasticity:

(a) When the fraction of the dry sample passing the No. 100 mesh sieve is 4% or less by weight, no plastic limit test will be made.

(b) When the fraction of the dry sample passing the No. 100 mesh sieve is greater than 4% and not greater than 8% by weight, that fraction shall not have sufficient plasticity to permit the performing of the plastic limit test using AASHTO Method T 90.

(c) When the fraction of the dry sample passing the No. 100 mesh sieve is greater than 8% by weight, the sample will be washed; and the additional material passing the No. 100 mesh sieve shall be determined by AASHTO Method T 146, except that the No. 100 mesh sieve will be substituted for the No. 40 mesh sieve where the latter is specified in AASHTO Method T 146. The combined materials that passed the No. 100 mesh sieve shall not have sufficient plasticity to permit the performing of the plastic limit test using AASHTO Method T 90.

3. Test for Resistance to Abrasion. Gravel materials shall show a loss on abrasion of not more than 50% using AASHTO Method T 96.

4. Soundness: When tested with magnesium sulfate solution for soundness using AASHTO Method T 104, coarse aggregate shall not have a loss of more than 15% at the end of 5 cycles.

M.02.07—Free-Draining Materials: Free-draining material shall consist of sand, gravel, rock fragments, quarry run stone, broken stone, reclaimed miscellaneous aggregate containing no more than 2% by weight of asphalt cement or mixtures thereof. This material, or the material from any one source of a mixture, shall not have more than 70%, by weight, passing the No. 40 mesh sieve and not more than 10%, by weight, passing the No. 200 mesh sieve.

SECTION M.04
BITUMINOUS CONCRETE MATERIALS

M.04.01—Bituminous Concrete Materials and Facilities
M.04.02—Mix Design and Job Mix Formula (JMF)
M.04.03—Production Requirements

M.04.01—Bituminous Concrete Materials and Facilities: Each source of asphalt binder, emulsion, aggregate, and production facility used to manufacture bituminous concrete mixture , and laboratory testing the mixture must be qualified on an annual basis by the Engineer.

The basis of qualification for asphalt binder sources is participation in AASHTO Product Evaluation and Audit Solutions (formerly NTPEP), Asphalt Binder Suppliers (ABS) program and review of the sources' Quality System Manual and on-site audit report from AASHTO Product Evaluation and Audit Solutions by the Department. In addition, each source must submit monthly split samples to the Department's Central Laboratory for each grade of binder currently or potentially supplied to Department projects.

The basis of qualification for emulsion sources is the submittal of a "Quality Control Plan for Emulsified Asphalt" (Tack Coat) formatted in accordance with AASHTO R 77 to the Engineer for review. In addition, a split sample per grade must be submitted to the Department's Central Laboratory on a monthly basis.

The basis of qualification for aggregates is indicated in M.01

The basis of qualification for production facilities is indicated in M.04.01-10.

The basis of testing laboratory qualification for mixture testing is all testing equipment, supplies, and safety equipment shall be capable of performing all the applicable tests in their entirety that are referenced in AASHTO R 35 and AASHTO M 323 and requirements indicated in M.04.01-11

AASHTO/ASTM Standards noted with an (M) have been modified and are detailed in Table M.04.03-5.

Aggregates from multiple sources of supply must not be blended or stored in the same stockpile.

1. **Coarse Aggregate:** All coarse aggregate shall meet the requirements listed in M.01.
2. **Fine Aggregate:** All fine aggregate shall meet the requirements listed in M.01.
3. **Mineral Filler:** Mineral filler shall conform to the requirements of AASHTO M 17.
4. **Performance Graded (PG) Asphalt Binder:**

(a) General:

i. PG asphalt binder shall be uniformly mixed and blended and be free of contaminants such as fuel oils and other solvents. Binder shall be properly heated and stored to prevent damage or separation.

ii. The binder shall meet the requirements of AASHTO M 332 and shall be graded or verified in accordance with AASHTO R 29. The Contractor shall submit a Certified Test Report and bill of lading representing each delivery in accordance with AASHTO R 26(M). The Certified Test Report must also indicate the binder specific gravity at 77°F; rotational viscosity at 275°F and 329°F; and the mixing and compaction viscosity-temperature chart for each shipment.

iii. The Contractor shall submit the name(s) of personnel responsible for receipt, inspection, and record keeping of PG binder. Contractor Plant personnel shall document specific storage tank(s) where binder will be transferred and stored until used and provide binder samples from the storage tank to the Engineer upon request. The person(s) shall assure that each shipment is accompanied by a statement certifying that the transport vehicle was inspected before loading was found acceptable for the material shipped and that the binder is free of contamination from any residual material, along with 2 copies of the bill of lading.

iv. The blending or combining of PG binders in one storage tank at the Plant from different suppliers, grades, or additive percentages is prohibited.

(b) Standard Performance Grade (PG) Binder:

i. Standard PG binder shall be defined as "Neat." Neat PG binders shall be free from modification with: fillers, extenders, reinforcing agents, adhesion promoters, thermoplastic polymers, acid modification and other additives such as re-refined motor oil, and shall indicate such information on each bill of lading and Certified Test Report.

ii. The standard asphalt binder shall be PG 64S-22.

(c) Modified Performance Grade (PG) Binder: The modified asphalt binder shall be Performance Grade PG 64E-22 asphalt modified solely with a Styrene-Butadiene-Styrene (SBS) polymer. The polymer modifier shall be added at either the refinery or terminal and delivered to the bituminous

concrete production facility as homogenous blend. The stability of the modified binder shall be verified in accordance with ASTM D7173 using the Dynamic Shear Rheometer (DSR). The DSR G*/sin(δ) results from the top and bottom sections of the ASTM D7173 test shall not differ by more than 10%. The results of ASTM D7173 shall be included on the Certified Test Report. The binder shall meet the requirements of AASHTO M 332 (including Appendix X1) and AASHTO R 29.

(d) Warm Mix Additive or Technology:

i. The warm mix additive or technology must be listed on the North East Asphalt User Producer Group (NEAUPG) Qualified Warm Mix Asphalt (WMA) Technologies List at the time of bid, which may be accessed online at http://www.neaupg.uconn.edu.

ii. The warm mix additive shall be blended with the asphalt binder in accordance with the manufacturer's recommendations.

iii. The blended binder shall meet the requirements of AASHTO M 332 and shall be graded or verified in accordance with AASHTO R 29 for the specified binder grade. The Contractor shall submit a Certified Test Report showing the results of the testing demonstrating the binder grade. In addition, it must include the grade of the virgin binder, the brand name of the warm mix additive, the manufacturer's suggested rate for the WMA additive, the water injection rate (when applicable), and the WMA Technology manufacturer's recommended mixing and compaction temperature ranges.

5. Emulsified Asphalts:

(a) General:

i. The emulsified asphalt shall meet the requirements of AASHTO M 140(M), AASHTO M 208, or as applicable herein.

ii. The emulsified asphalts shall be free of contaminants such as fuel oils and other solvents.

iii. The blending at mixing Plants of emulsified asphalts from different suppliers is prohibited.

iv. Materials used for tack coat shall not be diluted.

(b) Basis of Approval:

i. Each shipment of emulsified asphalt delivered to the Project site shall be accompanied with the corresponding Certified Test Report listing Saybolt viscosity, residue by evaporation, penetration of residue, and weight per gallon at 77°F or 60°F, and a Material Certificate.

ii. Non-Tracking Asphalt Tack Coat

– Emulsion for Non-Tracking Asphalt Tack Coat shall meet the requirements of Table M.04.01-1 below.

Table M.04.01-1: Asphalt Emulsion for Non-Tracking Tack Coat

Property	Specification	Test Procedure
Viscosity, SFS, 77°F	20-100	AASHTO T 72
Sieve, %	0.3 maximum	AASHTO T 59
Asphalt Residue, %	50 minimum	AASHTO T 59
Oil Distillate, %	1.0 maximum	AASHTO T 59
Residue Penetration, at 77°F	10-40	AASHTO T 49
Original Dynamic Shear (G*/sin δ), kPa at 70°C (Base Asphalt)	1.0 minimum	AASHTO T 315
Ash, %	1.0 maximum	AASHTO T 111

iii. Material for Tack Coat

– Anionic emulsified asphalts shall meet the requirements of AASHTO M 140. Materials used for anionic tack coat shall meet grade RS-1 or RS-1h. When ambient temperatures are 80°F and rising, grade SS-1 or SS-1h may be substituted if permitted by the Engineer.

– Cationic emulsified asphalt shall meet the requirements of AASHTO M 208. Materials used for cationic tack coat shall meet grade CRS-1. The settlement and demulsibility test will not be performed unless deemed necessary by the Engineer. When ambient temperatures are 80°F and rising, grade CSS-1 or CSS-1h may be substituted if permitted by the Engineer.

6. Reclaimed Asphalt Pavement (RAP):

(a) General: RAP is a material obtained from the cold milling or removal and processing of bituminous concrete pavement. RAP material shall be crushed to 100% passing the 1/2 inch sieve and free from contaminants such as joint compound, wood, plastic, and metals.

(b) Basis of Approval: The RAP material will be accepted on the basis of one of the following criteria:

i. When the source of all RAP material is from pavements previously constructed on Department projects, the Contractor shall provide a Materials Certificate listing the detailed locations and lengths of those pavements and that the RAP is only from those locations listed.

ii. When the RAP material source or quality is not known, the Contractor shall request approval from the Engineer at least 30 calendar days prior to the start of the paving operation. The request shall include a Material Certificate and applicable test results stating that the RAP consists of aggregates that meet the specification requirements of M.04.01-1 through M.04.01-3 and that the binder in the RAP is substantially free of solvents, tars and other contaminants. The Contractor is prohibited from using unapproved material on Department projects and shall take necessary action to prevent contamination of approved RAP stockpiles. Stockpiles of unapproved material shall remain separate from all other RAP materials at all times. The request for approval shall include the following:

1. A 50-lb. sample of the RAP to be incorporated into the recycled mixture.
2. A 25-lb. sample of the extracted aggregate from the RAP.

7. Crushed Recycled Container Glass (CRCG):

(a) Requirements: The Contractor may propose to use clean and environmentally-acceptable CRCG in an amount not greater than 5% by weight of total aggregate.

(b) Basis of Approval: The Contractor shall submit to the Engineer a request to use CRCG. The request shall state that the CRCG contains no more than 1% by weight of contaminants such as paper, plastic, and metal and conforms to the following gradation:

CRCG Grading Requirements	
Sieve Size	Percent Passing
3/8 inch	100
No. 4	35-100
No. 200	0.0-10.0

The Contractor shall submit a Material Certificate to the Engineer stating that the CRCG complies with all the applicable requirements in this Section.

8. Joint Seal Material: Joint seal material must meet the requirements of ASTM D6690 - Type 2. The Contractor shall submit a Material Certificate in accordance with 1.06.07 or 1.20-1.06.07 certifying that the joint seal material meets the requirements of this Section.

9. Recycled Asphalt Shingles (RAS): RAS shall consist of processed asphalt roofing shingles from post-consumer asphalt shingles or from manufactured shingle waste. The RAS under consideration for use in bituminous concrete mixtures must be certified as being asbestos-free and shall be entirely free of whole, intact nails. The RAS shall meet the requirements of AASHTO MP 23.

RAS shall be tested to determine the asphalt content and the gradation at a frequency acceptable to the Engineer. RAS stockpiles shall be maintained to prevent contamination.

The Contractor shall submit a Material Certificate to the Engineer stating that the RAS complies with all the applicable requirements.

10. Plant Requirements:

(a) General: The Plant producing bituminous concrete shall comply with AASHTO M 156.

(b) Storage Silos: The Contractor may use silos for short-term storage with the approval of the Engineer. A storage silo must have heated cones and an unheated silo cylinder if it does not contain a separate internal heating system. When multiple silos are filled, the Contractor shall discharge 1 silo at a time. Simultaneous discharge of multiple silos for the same Project is not permitted.

Type of silo cylinder	Maximum storage time for all classes (hr)	
	HMA	WMA/PMA
Open Surge	4	Mfg Recommendations*
Unheated - Non-insulated	8	Mfg Recommendations*
Unheated - Insulated	18	Mfg Recommendations*
Heated - No inert gas	TBD by the Engineer	TBD by the Engineer

*Not to exceed HMA limits

(c) Documentation System: The mixing Plant documentation system shall include equipment for accurately proportioning the components of the mixture by weight and in the proper order, controlling the cycle sequence, and timing the mixing operations. Recording equipment shall monitor the batching sequence of each component of the mixture and produce a printed record of these operations on each Plant ticket, as specified herein.

If recycled materials are used, the Plant tickets shall include their dry weight, percentage, and daily moisture content.

If a WMA Technology is added at the Plant, the Plant tickets shall include the actual dosage rate.

For drum Plants, the Plant ticket shall be produced at 5 minute intervals and maintained by the vendor for a period of 3 years after the completion of the Project.

For batch Plants, the Plant ticket shall be produced for each bath and maintained by the vendor for a period of 3 years after the completion of the Project. In addition, an asterisk (*) shall be automatically printed next to any individual batch weight(s) exceeding the following tolerances:

Each Aggregate Component	±1.5% of individual or cumulative target weight for each bin
Mineral Filler	±0.5% of the total batch
Bituminous Material	±0.1% of the total batch
Zero Return (Aggregate)	±0.5% of the total batch
Zero Return (Bituminous Material)	±0.1% of the total batch

The entire batching and mixing interlock cut-off circuits shall interrupt and stop the automatic batching operations when an error exceeding the acceptable tolerance occurs in proportioning.

The scales shall not be manually adjusted during the printing process. In addition, the system shall be interlocked to allow printing only when the scale has come to a complete rest. A unique printed character (m) shall automatically be printed on the truck and batch plant printout when the automatic batching sequence is interrupted or switched to auto-manual or full manual during proportioning.

(d) Aggregates: Aggregate stockpiles shall be managed to prevent segregation and cross contamination. For drum Plants only, the percent moisture content, at a minimum prior to production and half way through production, shall be determined.

(e) Mixture: The dry and wet mix times shall be sufficient to provide a uniform mixture and a minimum particle coating of 95% as determined by AASHTO T 195(M).

Bituminous concrete mixtures shall contain no more than 0.5% moisture when tested in accordance with AASHTO T 329.

(f) RAP: RAP moisture content shall be determined a minimum of twice daily (prior to production and halfway through production).

(g) Asphalt Binder: A binder log shall be submitted to the Department's Central Lab on a monthly basis.

(h) Warm mix additive: For mechanically foamed WMA, the water injection rate shall be monitored during production and not exceed 2.0% by total weight of binder. For additive added at the Plant, the

dosage rate shall be monitored during production.

11. Testing Laboratory: The laboratory shall be provided with functioning equipment and adequate supplies to test bituminous concrete mixtures during production. The laboratory shall have a minimum of 300 s.f., have a potable water source and drainage in accordance with the CT Department of Public Health Drinking Water Division. The laboratory shall have a PC with internet connection capable of submitting electronic test results to the Engineer.

The laboratory shall be equipped with a heating system capable of maintaining a minimum temperature of 65°F. It shall be clear and free of all materials and equipment not associated with the laboratory. Sufficient light and ventilation must be provided. During summer months adequate cooling or ventilation must be provided so the indoor air temperature shall not exceed the ambient outdoor temperature.

The laboratory shall maintain a list of equipment used in the acceptance testing processes including, but not limited to, balances, scales, manometer/vacuum gauge, thermometers, and gyratory compactor, clearly showing calibration and/or inspection dates, in accordance with AASHTO R 18.

M.04.02—Mix design and Job Mix Formula (JMF)

1. Curb Mix:

(a) Requirements: The Contractor shall use bituminous concrete that meets the requirements of Table M.04.02-1. RAP may be used in 5% increments by weight up to 30%.

(b) Basis of Approval: Annually, an approved JMF based on a mix design for curb mix must be on file with the Engineer prior to use.

The Contractor shall test the mixture for compliance with the submitted JMF and Table M.04.02-1. The maximum theoretical density (Gmm) will be determined by AASHTO T 209. If the mixture does not meet the requirements, the JMF shall be adjusted within the ranges shown in Table M.04.02-1 until an acceptable mixture is produced.

An accepted JMF from the previous operating season may be acceptable to the Engineer provided that there are no changes in the sources of supply for the coarse aggregate, fine aggregate, recycled material (if applicable) and the Plant operation had been consistently producing acceptable mixture.

Any change in component source of supply or consensus properties must be approved by the Engineer. A revised JMF shall be submitted prior to use.

TABLE M.04.02-1:
Control Points for Curb Mix Mixtures

Mix	Curb Mix	Production Tolerances from JMF Target
Grade of PG Binder content %	**PG 64S-22 6.5 - 9.0**	**0.4**
Sieve Size		
No. 200	3.0 - 8.0 (b)	2.0
No. 50	10 - 30	4
No. 30	20 - 40	5
No. 8	40 - 70	6
No. 4	65 - 87	7
1/4 inch		
3/8 inch	95 - 100	8
1/2 inch	100	8
3/4 inch		8
1 inch		
2 inch		
Additionally, the fraction of material retained between any 2 consecutive sieves shall not be less than 4%.		
Mixture Temperature		
Binder	325°F maximum	
Aggregate	280-350°F	
Mixtures	265-325°F	
Mixture Properties		
Air Voids (VA) %	0 – 4.0 (a)	

Notes: (a) Compaction Parameter 50 gyrations (N_{des})
(b) The percent passing the No. 200 sieve shall not exceed the percentage of bituminous asphalt binder.

2. Superpave Design Method – S0.25, S0.375, S0.5, and S1:

(a) Requirements: All designated mixes shall be designed using the Superpave mix design method in accordance with AASHTO R 35. A JMF based on the mix design shall meet the requirements of Tables M.04.02-2 to M.04.02-5. Each JMF and component samples must be submitted no less than 7 days prior to production and must be approved by the Engineer prior to use. All JMFs expire at the end of the calendar year.

All aggregate component consensus properties and tensile strength ratio (TSR) specimens shall be tested at an AASHTO accredited laboratory AASHTO re:source by NETTCP Certified Technicians.

All bituminous concrete mixes shall be tested for stripping susceptibility by performing the TSR test procedure in accordance with AASHTO T 283(M) at a minimum every 36 months. The compacted specimens may be fabricated at the Plant and then tested at an AASHTO re:source accredited facility. A minimum of 45000 grams of laboratory or plant blended mixture and the corresponding complete Form MAT-412s shall be submitted to the Department's Central Laboratory for design TSR testing verification. The mixture submitted shall be representative of the corresponding mix design as determined by the Engineer.

i. Superpave Mixtures with RAP: RAP may be used with the following conditions:
   - RAP amounts up to 15% may be used with no binder grade modification.
   - RAP amounts up to 20% may be used provided a new JMF is approved by the Engineer. The

JMF submittal shall include the grade of virgin binder added. The JMF shall be accompanied by a blending chart and supporting test results in accordance with AASHTO M 323 Appendix X1, or by testing that shows the combined binder (recovered binder from the RAP, virgin binder at the mix design proportions, warm mix asphalt additive and any other modifier if used) meets the requirements of the specified binder grade.

- Two (2) representative samples of RAP shall be obtained. Each sample shall be split, and 1 split sample shall be tested for binder content in accordance with AASHTO T 164 and the other in accordance with AASHTO T 308.
- RAP material shall not be used with any other recycling option.

ii. Superpave Mixtures with RAS: RAS may be used solely in HMA S1 mixtures with the following conditions:

- RAS amounts up to 3% may be used.
- RAS total binder replacement up to 15% may be used with no binder grade modification.
- RAS total binder replacement up to 20% may be used provided a new JMF is approved by the Engineer. The JMF submittal shall include the grade of virgin binder added. The JMF shall be accompanied by a blending chart and supporting test results in accordance with AASHTO M 323 Appendix X1, or by testing that shows the combined binder (recovered binder from the RAP, virgin binder at the mix design proportions, warm mix asphalt additive and any other modifier if used) meets the requirements of the specified binder grade.
- Superpave Mixtures with RAS shall meet AASHTO PP 78 design considerations.

iii. Superpave Mixtures with CRCG: CRCG may be used solely in HMA S1 mixtures. One percent (1%) of hydrated lime, or other accepted non-stripping agent, shall be added to all mixtures containing CRCG. CRCG material shall not be used with any other recycling option.

(b) Basis of Approval: The following information must be included in the JMF submittal:

i. Gradation, consensus properties and specific gravities of the aggregate, RAP or RAS.
ii. Average asphalt content of the RAP or RAS by AASHTO T 164.
iii. Source of RAP or RAS and percentage to be used.
iv. Warm mix Technology, manufacturer's recommended additive rate and tolerances, and manufacturer recommended mixing and compaction temperatures.
v. TSR test report and anti-strip manufacturer and recommended dosage rate if applicable.
vi. Mixing and compaction temperature ranges for the mix with and without the warm-mix technology incorporated.
vii. JMF ignition oven correction factor by AASHTO T 308.

With each JMF submittal, the following samples shall be submitted to the Division of Materials Testing:

- 4 - one (1) quart cans of PG binder, with corresponding Safety Data Sheet (SDS)
- 1 - 50 lbs. bag of RAP
- 2 - 50 lbs. bags of Plant-blended virgin aggregate

A JMF may not be approved if any of the properties of the aggregate components or mix do not meet the verification tolerances as described in the Department's current QA Program for Materials, Acceptance and Assurance Testing Policies and Procedures.

Any material based on a JMF, once approved, shall only be acceptable for use when it is produced by the designated Plant, it utilizes the same components, and the production of material continues to meet all criteria as specified in Tables M.04.02-2, M.04.02-3 and M.04.02-4. A new JMF must be submitted to the Engineer for approval whenever a new component source is proposed.

Only 1 mix with 1 JMF will be approved for production at a time. Switching between approved JMF mixes with different component percentages or sources of supply is prohibited.

TABLE M.04.02-2: Superpave Master Range for Bituminous Concrete Mixture Design Criteria

	S0.25		**S0.375**		**S0.5**		**S1**	
Sieve	Control Points		Control Points		Control Points		Control Points	
inches	Min (%)	Max (%)	Min (%)	Max (%)	Min (%)	Max (%)	Min (%)	Max (%)
2.0	-	-	-	-	-	-	-	-
1.5	-	-	-	-	-	-	100	-
1.0	-	-	-	-	-	-	90	100
3/4	-	-	-	-	100	-	-	90
1/2	100	-	100	-	90	100	-	-
3/8	97	100	90	100	-	90	-	-
No. 4	72	90	-	72	-	-	-	-
No. 8	32	67	32	67	28	58	19	45
No. 16	-	-	-	-	-	-	-	-
No. 30	-	-	-	-	-	-	-	-
No. 50	-	-	-	-	-	-	-	-
No. 100	-	-	-	-	-	-	-	-
No. 200	2.0	10.0	2.0	10.0	2.0	10.0	1.0	7.0
VMA (%)	16.5 ± 1		16.0 ± 1		15.0 ± 1		13.0 ± 1	
VA (%)	4.0 ± 1		4.0 ± 1		4.0 ± 1		4.0 ± 1	
Gse	JMF value		JMF value		JMF value		JMF value	
Gmm	JMF ± 0.030		JMF ± 0.030		JMF ± 0.030		JMF ± 0.030	
Dust / effective binder	0.6 - 1.2		0.6 - 1.2		0.6 - 1.2		0.6 - 1.2	
TSR	≥ 80%		≥ 80%		≥ 80%		≥ 80%	
T-283 Stripping	Minimal as determined by the Engineer							

(c) Mix Status: Each facility will have each type of bituminous concrete mixture rated based on the results of the previous year of production. Mix status will be developed for each bituminous concrete facility prior to the beginning of the paving season.

The rating criteria are based on compliance with Air Voids and Voids in Mineral Aggregate (VMA) as indicated in Table M.04.03-4 and are calculated as follows:

Criteria A: Percentage of acceptance test results with compliant air voids.

Criteria B: The average of the percentage of acceptance results with compliant VMA and the percentage of acceptance results with compliant air voids.

The final rating assigned will be the lower of the rating obtained with Criteria A or Criteria B.

Mix status is defined as:

"A" – Approved: Assigned to each mixture type from a production facility with a current rating of 70% or greater, or to each mixture type completing a successful PPT.

"U" – Not Approved: Status assigned to a type of mixture that does not have an approved JMF. Bituminous concrete mixtures with a "U" status cannot be used on Department projects.

"PPT" – Pre-Production Trial: Temporarily assigned to each mixture type from a production facility when:

1. no compliant acceptance production test results have been submitted to the Department from the previous year;
2. there is a source change in one or more aggregate components;
3. there is a component percentage change of more than 5% by weight;
4. there is a change in RAP percentage;
5. the mixture has a rating of less than 70% from the previous season;
6. it is a new JMF not previously submitted; or
7. the average of 10 consecutive acceptance results for VFA, Density to N_{ini} or dust to effective binder ratio does not meet the criteria in tables M.04.02-2 and M.04.02-4.

Bituminous concrete mixtures rated with a "PPT" status cannot be used on Department projects until modifications are made at the facility. Sufficient testing by NETTCP certified personnel must confirm that specification requirements in Tables M.04.02-2 through M.04.02-4 are met and the binder content (Pb) meets the requirements in Table M.04.03-2 before material can be used. One of the following methods must be used to verify the test results:

Option A: Schedule a day when a Department Inspector can be at the facility to witness testing

Option B: When the Contractor or their representative performs testing without being witnessed by an Inspector, the Contractor shall submit the test results and a split sample including 2 gyratory molds, 5,000 grams of boxed bituminous concrete, and 5,000 grams of cooled loose bituminous concrete for verification testing and approval

Option C: When the Contractor or their representative performs testing without being witnessed by a Department Inspector, the Engineer may verify the mix in the Contractor's laboratory.

Department Witness or verification of compliant test results will change the mix's status to "A"

The differences between the Department's test results and the Contractor's must be within the "C" tolerances included in the Department's QA Program for Materials in order to be verified.

TABLE M.04.02-3: Superpave Consensus Properties Requirements for Combined Aggregate

Traffic Level	Design ESALs (80kN) Millions	Coarse Aggregate Angularity[(1)] ASTM D5821, Minimum %	Fine Aggregate Angularity AASHTO T 304, Method A Minimum %	Flat and Elongated Particles[(2)] ASTM D4791, Maximum %	Sand Equivalent AASHTO T 176, Minimum %
1	< 0.3	55/- -	40	10	40
2	0.3 to < 3.0	75/- -	40	10	40
3	≥ 3.0	95/90	45	10	45

Notes:

(1) 95/90 denotes that a minimum of 95% of the coarse aggregate, by mass, shall have one fractured face and that a minimum of 90% shall have two fractured faces.

(2) Criteria presented as maximum Percent by mass of flat and elongated particles of materials retained on the No. 4 sieve, determined at 5:1 ratio.

TABLE M.04.02-4: Superpave Traffic Levels and Design Volumetric Properties

Traffic Level	Design ESALs	Number of Gyrations by Superpave Gyratory Compactor			Percent Density of Gmm from HMA/ WMA Specimen			Voids Filled with Asphalt (VFA) Based on Nominal Mix Size - Inch			
	(million)	N_{ini}	N_{des}	N_{max}	N_{ini}	N_{des}	N_{max}	0.25	0.375	0.5	1
1	<0.3	6	50	75	≤91.5	96.0	≤98.0	70-80	70-80	70-80	67-80
2	0.3 to <3.0	7	75	115	≤90.5	96.0	≤98.0	65-78	65-78	65-78	65-78
3	≥3.0	7	75	115	≤90.0	96.0	≤98.0	65-77	65-76	65-75	65-75

TABLE M.04.02-5:
Superpave Minimum Binder Content by Mix Type and Level

Mix Type	Level	Binder Content Minimum
S0.25	1	5.80
S0.25	2	5.70
S0.25	3	5.70
S0.375	1	5.70
S0.375	2	5.60
S0.375	3	5.60
S0.5	1	5.10
S0.5	2	5.00
S0.5	3	5.00
S1	1	4.60
S1	2	4.50
S1	3	4.50

M.04.03—Production Requirements:

1. Standard Quality Control Plan (QCP) for Production: The QCP for production shall describe the organization and procedures, which the Contractor shall use to administer quality control. The QCP shall include the procedures used to control the production process, to determine when immediate changes to the processes are needed, and to implement the required changes. The QCP must detail the inspection, sampling and testing protocols to be used, and the frequency for each.

Control Chart(s) shall be developed and maintained for critical aspect(s) of the production process as determined by the Contractor. The control chart(s) shall identify the material property, applicable upper and lower control limits, and be updated with current test data. As a minimum, the following quality characteristics shall be included in the control charts:

- percent passing No. 4 sieve
- percent passing No. 200 sieve
- binder content
- air voids
- Gmm
- Gse

- VMA

The control chart(s) shall be used as part of the quality control system to document variability of the bituminous concrete production process. The control chart(s) shall be submitted to the Engineer the first day of each month.

The QCP shall also include the name and qualifications of a Quality Control Manager. The Quality Control Manager shall be responsible for the administration of the QCP, including compliance with the plan and any plan modifications.

The Contractor shall submit complete production testing records to the Engineer within 24 hours in a manner acceptable to the Engineer.

The QCP shall also include the name and qualifications of any outside testing laboratory performing any QC functions on behalf of the Contractor. The QCP must also include a list of sampling and testing methods and frequencies used during production, and the names of all Quality Control personnel and their duties.

Approval of the QCP does not imply any warranty by the Engineer that adherence to the plan will result in production of bituminous concrete that complies with these specifications. The Contractor shall submit any changes to the QCP as work progresses.

2. Acceptance Requirements:

(a) General:

For those mixes with a total estimated project tonnage over 500 tons, a Contractor representative shall obtain a field sample of the material placed at the project site in accordance with AASHTO R 97 or an alternate procedure approved by the Engineer. Sampling from the truck at the Plant in accordance with AASHTO R 97 will be allowed for those mixes with a total estimated project tonnage equal to or less than 500 tons. The Contractor's representative obtaining mix samples must be a certified NETTCP HMA Paving Inspector, NETTCP HMA Plant Technician, or has successfully completed the HMA Field Sampling Course administered by the Connecticut Advanced Pavement Laboratory. Regardless of sampling location, the sample shall be quartered by the Contractor in accordance with AASHTO R 47 and placed in an approved container. For samples obtained at the project site, a Type A Mechanical Splitter shall be used to quarter the sample in accordance with AASHTO R 47. The container shall be sealed with a security tape provided by the Department and labelled to include the project number, date of paving, mix type, lot and sublot numbers and daily tonnage. The minimum weight of each quartered sample shall be 14000 grams. The Contractor shall transport one of the containers to the Departments Central Laboratory in Rocky Hill, retain one of the sealed containers for potential use in dispute resolution and test the remaining samples for acceptance in accordance with past practice.

The Contractor shall submit all acceptance tests results to the Engineer within 24 hours or prior to the next day's production. All acceptance test specimens and supporting documentation must be retained by the Contractor and may be disposed of with the approval of the Engineer. All quality control specimens shall be clearly labeled and separated from the acceptance specimens.

Contractor personnel performing QC and acceptance testing must be present at the facility prior to, during, and until completion of production, and be certified as a NETTCP HMA Plant Technician and be in good standing. Production of material for use on State projects must be suspended by the Contractor if such personnel are not present. Technicians found by the Engineer to be non-compliant with NETTCP policies and procedures or Department policies may be removed by the Engineer from participating in the acceptance testing process for Department projects until their actions can be reviewed.

Verification and dispute resolution testing will be performed by the Engineer in accordance with the Department's QA Program for Materials.

If the Contractor disputes the Engineer's test results, the Contractor must submit in writing a request to initiate the dispute resolution process within 24 hours of receiving the adjustment and must include supporting documentation or test results to justify the request. If the dispute resolution is granted by the Engineer, all sublots for the disputed lot(s) shall be transported by the Contractor to the Department's Central Laboratory for testing.

(b) Curb Mix Acceptance Sampling and Testing Procedures: Curb Mixes shall be tested by the Contractor at a frequency of 1 test per every 250 tons of cumulative production, regardless of the day of production. When these mix designs are specified, the following acceptance procedures and AASHTO test methods shall be used:

TABLE M.04.03-1: Curb Mix Acceptance Test Procedures

Protocol	Reference	Description
1	**AASHTO T 30(M)**	Mechanical Analysis of Extracted Aggregate
2	**AASHTO R 97**	Sampling of Bituminous Concrete
3	**AASHTO T 308**	Binder Content by Ignition Oven Method (adjusted for aggregate correction factor)
4	**AASHTO T 209(M)[(2)]**	Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures
5	**AASHTO T 312[(2)]**	[(1)]Superpave Gyratory Molds Compacted to N_{des}
6	**AASHTO T 329**	Moisture Content of Hot-Mix Asphalt (HMA) by Oven Method

Notes: [(1)] One (1) set equals 2 each of 6 inch molds. Molds to be compacted to 50 gyrations.
[(2)] Once per year or when requested by the Engineer.

i. Determination of Off-Test Status:
1. Curb Mix is considered "off test" when the test results indicate that any single value for bitumen content or gradation are not within the tolerances shown in Table M.04.02-1 for that mixture. If the mix is "off test," the Contractor must take immediate actions to correct the deficiency and a new acceptance sample shall be tested on the same day or the following day of production.
2. When multiple silos are located at 1 site, mixture supplied to 1 project is considered as coming from 1 source for the purpose of applying the "off test" status.
3. The Engineer may cease supply from the Plant when test results from 3 consecutive samples are not within the JMF tolerances or the test results from 2 consecutive samples not within the control points indicated in Table M.04.02-1 regardless of production date.

ii. JMF Revisions
1. If a test indicates that the bitumen content or gradation are outside the tolerances, the Contractor may make a single JMF revision as allowed by the Engineer prior to any additional testing. Consecutive test results outside the requirements of Table M.04.02-1 JMF tolerances may result in rejection of the mixture.
2. Any modification to the JMF shall not exceed 50% of the JMF tolerances indicated in Table M.04.02-1 for any given component of the mixture without approval of the Engineer. When such an adjustment is made to the bitumen, the corresponding production percentage of bitumen shall be revised accordingly.

(c) Superpave Mix Acceptance:

i. Sampling and Testing Procedures

Production Lot: The lot will be defined as one of the following types:
- Non-PWL Production Lot for total estimated Project quantities per mixture less than 3500 tons: All mixture placed during a single continuous paving operation.
- PWL Production Lot for total estimated Project quantities per mixture of 3500 tons or more: Each 3500 tons of mixture produced within 30 calendar days.

Production Sub Lot:
- For Non-PWL: As defined in Table M.04.03-2
- For PWL: 500 tons (The last sub lot may be less than 500 tons.)

Partial Production Lots (For PWL only): A Lot with less than 3500 tons due to:
- completion of the course;
- a Job Mix Formula revision due to changes in:
  - cold feed percentages over 5%,
  - target combined gradation over 5%,
  - target binder over 0.15%,
  - any component specific gravity; or
- a lot spanning 30 calendar days.

The acceptance sample(s) location(s) shall be selected using stratified - random sampling in accordance with ASTM D3665 based on:
- the total daily estimated tons of production for non-PWL lots, or

- the total size for PWL lots.

The payment adjustment will be calculated as described in 4.06.

TABLE M.04.03-2:
Superpave Acceptance Testing Frequency per Mix Type/Level/Plant for Non-PWL Lots

Daily Quantity Produced in Tons (Lot)	Number of Sub Lots/Tests
0 to 125	0, Unless requested by the Engineer
126 to 500	1
501 to 1,000	2 (1)
1,001 to 1,500	3 (1)
1,501 or greater	1 per 500 tons or portions thereof

Notes: (1) For daily quantities produced over 500 tons, the final acceptance test shall always be performed with material from the last sub lot regardless of the predetermined random selections

The following test procedures shall be used for acceptance:

TABLE M.04.03-3: Superpave Acceptance Testing Procedures

Protocol	Procedure	Description
1	AASHTO R 97	Sampling of bituminous concrete
2	AASHTO R 47	Reducing samples to testing size
3	AASHTO T 308	Binder content by ignition oven method (adjusted for aggregate correction factor)
4	AASHTO T 30(M)	Gradation of extracted aggregate for bituminous concrete mixture
5	AASHTO T 312	(1)Superpave gyratory molds compacted to N_{des}
6	AASHTO T 166	(2)Bulk specific gravity of bituminous concrete
7	AASHTO R 35	(2)Air voids, VMA
8	AASHTO T 209(M)	Maximum specific gravity of bituminous concrete (average of 2 tests)
9	AASHTO T 329	Moisture content of bituminous concrete

Notes: (1) One (1) set equals 2 each of 6 inch molds. Molds to be compacted to Nmax for PPTs and to Ndes for production testing. The first sub lot of the year shall be compacted to N_{max}.

(2) Average value of 1 set of 6 inch molds.

If the average ignition oven corrected binder content differs by 0.3% or more from the average of the Plant ticket binder content in 5 consecutive tests regardless of the production date (moving average), the Contractor shall immediately investigate, determine an assignable cause, and correct the issue. When 2 consecutive moving average differences are 0.3% or more and no assignable cause has been established, the Engineer may require a new ignition oven aggregate correction factor to be performed or to adjust the current factor by the average of the differences between the corrected binder content and production Plant ticket for the last 5 acceptance results.

The Contractor shall perform TSR testing within 30 days after the start of production for all design levels of HMA- and PMA- S0.5 Plant-produced mixtures, in accordance with AASHTO T 283(M). The TSR test shall be performed at an AASHTO re:source certified laboratory by NETTCP certified technicians. The compacted specimens may be fabricated at the Plant and then tested at an AASHTO re:source accredited facility. A minimum of 45000 grams of plant blended mixture and the corresponding complete Form MAT-412s shall be submitted to the Department's Central Laboratory for production TSR testing verification. The mixture submitted shall be representative of the corresponding mix design as determined by the Engineer. Additionally, the TSR test report and tested specimens shall be submitted to the Engineer for review. Superpave mixtures that require anti-strip additives (either liquid or mineral) shall continue to meet all requirements specified herein for binder and bituminous concrete. The Contractor shall submit the name, manufacturer, percent used, technical datasheet and SDS

for the anti-strip additive (if applicable) to the Engineer.

i. Determination of Off-Test Status:
   1. Superpave mixes shall be considered *"off test"* when any control point sieve, binder content, VA, VMA, and Gmm value is outside of the limits specified in Table M.04.03-4 or the target binder content at the Plant is below the minimum binder content stated in Table M.04.02-5. Note that further testing of samples or portions of samples not initially tested for this purpose cannot be used to change the status.
   2. Any time the bituminous concrete mixture is considered off-test:
      A. The Contractor shall notify the Engineer when the Plant is *"off test"* for any mix design that is delivered to the Project in any production day. When multiple silos are located at 1 site, mixture supplied to 1 project is considered as coming from 1 source for the purpose of applying the *"off test"* determination.
      B. The Contractor must take immediate actions to correct the deficiency, minimize *"off test"* production to the Project, and obtain an additional Process Control (PC) test after any corrective action to verify production is in conformance with the specifications. A PC test will not be used for acceptance and is solely for the use of the Contractor in its quality control process.

ii. Cessation of Supply for Superpave Mixtures in Non-PWL Lots:

A mixture **shall not be used** on Department projects when it is "off test" for:

1. four (4) consecutive tests in any combination of VA, VMA or Gmm, regardless of date of production, or
2. two (2) consecutive tests in the control point sieves in 1 production shift.

As a result of cessation of supply, the mix status will be changed to PPT

iii. JMF revisions:

JMF revisions are only permitted prior to or after a production shift. A JMF revision is effective from the time it was submitted and is not retroactive to the previous test(s).

JMF revisions shall be justified by a documented trend of test results.

Revisions to aggregate or RAP specific gravities are only permitted when testing is performed at an AASHTO re:source certified laboratory by NETTCP certified technicians.

A JMF revision is required when the Plant target RAP or bin percentage deviates by more than 5% or the Plant target binder content deviates by more than 0.15% from the active JMF.

TABLE M.04.03-4: Superpave Mixture Production Requirements

	S0.25		**S0.375**		**S0.5**		**S1**		Tolerances
Sieve	Control Points		Control Points		Control Points		Control Points		From JMF Targets[2]
inches	Min (%)	Max (%)	Min (%)	Max (%)	Min (%)	Max (%)	Min (%)	Max (%)	+/- Tolerance
1.5	-	-	-	-	-	-	100	-	
1.0	-	-	-	-	-	-	90	100	
3/4	-	-	-	-	100	-	-	90	
1/2	100	-	100	-	90	100	-	-	
3/8	97	100	90	100	-	90	-	-	
No. 4	72	90	-	72	-	-	-	-	
No. 8	32	67	32	67	28	58	19	45	
No. 16	-	-	-	-	-	-	-	-	
No. 200	2.0	10.0	2.0	10.0	2.0	10.0	1.0	7.0	
Pb	JMF value		JMF value		JMF value		JMF value		0.3[3]
VMA (%)	16.5		16.0		15.0		13.0		1.0[4]
VA (%)	4.0		4.0		4.0		4.0		1.0[5]
Gmm	JMF value		JMF value		JMF value		JMF value		0.030
Mix Temp. – HMA[6]	265-325°F [1]		265-325°F [1]		265-325°F [1]		265-325°F [1]		
Mix Temp. – PMA[6]	285-335°F [1]		285-335°F [1]		285-335°F [1]		285-335°F [1]		
Prod. TSR	N/A		N/A		≥80%		N/A		
T 283 Stripping	N/A		N/A		Minimal TBD by the Engineer		N/A		

Notes: [1] 300°F minimum after October 15.

[2] JMF tolerances shall be defined as the limits for production compliance.

[3] 0.4 for PWL lots

[4] 1.3 for all PWL lots except S/P 0.25 mixes. 1.1 for S/P 0.25 Non-PWL lots. 1.4 for S/P 0.25 PWL lots

[5] 1.2 for PWL lots

[6] Also applies to placement

Table M.04.03-5:
Modifications to Standard AASHTO and ASTM Test Specifications and Procedures

AASHTO Standard Method of Test	
Reference	**Modification**
T 30	Section 7.2 through 7.4 Samples are not routinely washed for production testing
T 209	Section 7.2 The average of 2 bowls is used proportionally in order to satisfy minimum mass requirements. 8.3 Omit Pycnometer method.
T 283	When foaming technology is used, the material used for the fabrication of the specimens shall be cooled to room temperature, and then reheated to the manufacturer's recommended compaction temperature prior to fabrication of the specimens.
AASHTO Standard Recommended Practices	
Reference	**Modification**
R 26	All laboratory technician(s) responsible for testing PG binders shall be certified or Interim Qualified by NETTCP as a PG Asphalt Binder Lab Technician. All laboratories testing binders for the Department are required to be accredited by AASHTO re:source. Sources interested in being approved to supply PG binders to the Department by use of an "in-line blending system" must record properties of blended material and additives used. Each source of supply of PG binder must indicate that the binders contain no additives used to modify or enhance their performance properties. Binders that are manufactured using additives, modifiers, extenders, etc., shall disclose the type of additive, percentage and any handling specifications or limitations required. All AASHTO M 320 references shall be replaced with AASHTO M 332. Once a month, 1 split sample and test results for each asphalt binder grade and each lot shall be submitted by the PG binder supplier to the Department's Central Lab. Material remaining in a certified lot shall be re-certified no later than 30 days after initial certification. Each April and September, the PG binder supplier shall submit test results for 2 BBR tests at 2 different temperatures in accordance with AASHTO R 29.

SECTION M.05
PROCESSED AGGREGATE BASE AND PAVEMENT SURFACE TREATMENT

M.05.01—Processed Aggregate Base and Pavement
M.05.02—Surface Treatment

M.05.01—Processed Aggregate Base and Pavement: The materials for this work shall meet the following requirements:

1. Gradation: Coarse and fine aggregates shall be combined and mixed by approved methods so that the resulting material shall meet the following gradation requirements:

Table M.05.01-1

Square Mesh Sieves	Percent Passing by Weight
Pass 2 1/2 inches	100
Pass 2 inches	95-100
Pass 3/4 inch	50-75
Pass 1/4 inch	25-45
Pass No. 40	5-20
Pass No. 100	2-12

2. Coarse Aggregate: Coarse aggregate shall be either gravel, broken stone or reclaimed miscellaneous aggregate containing no more than 2% by weight of asphalt cement, at the option of the Contractor. When tested by means of the Los Angeles Machine, using AASHTO Method T 96, the coarse aggregate shall not have a loss of more than 50%.

(a) If gravel is used for the coarse aggregate, it shall consist of sound, tough, durable particles of crushed or uncrushed gravel or a mixture thereof, free from soft, thin, elongated or laminated pieces, lumps of clay, loam and vegetable or other deleterious substances.

(b) If broken stone is used for the coarse aggregate, it shall consist of sound, tough, durable fragments of rock of uniform quality throughout. It shall be free from soft disintegrated pieces, mud, dirt, organic or other injurious material.

(c) If the reclaimed miscellaneous aggregate is used for the coarse aggregate, it shall consist of sound, tough, durable fragments of uniform quality throughout. It shall be free from soft disintegrated pieces, mud, dirt, glass, organic or other injurious material.

(d) Soundness for Gravel, Broken Stone and Reclaimed Miscellaneous Aggregate: When tested by magnesium sulfate solution for soundness using AASHTO Method T 104, the coarse aggregate shall show a loss of not more than 15% at the end of 5 cycles.

3. Fine Aggregate: The fine aggregate shall be natural sand, stone sand, screenings or any combination thereof. The fine aggregate shall be limited to material 95% of which passes a No. 4 sieve having square openings and not more than 8% of which passes a No. 200 sieve. The material shall be free from clay, loam and deleterious materials.

(a) Plasticity: When natural sand is used, the fine aggregate shall conform to the requirements of M.02.06-2.

(b) Plasticity: When screenings or any combination of screenings and natural sand or any combination of stone sand and natural sand are used, the following requirements shall apply:

1. When the fraction of the dry sample passing the No. 100 mesh sieve is 6% or less by weight, no plastic limit test will be made.
2. When the fraction of the dry sample passing the No. 100 mesh sieve is greater than 6% and not greater than 10% by mass, that fraction shall not have sufficient plasticity to permit the performing of the plastic limit test, using AASHTO Method T 90.
3. When the fraction of the dry sample passing the No. 100 mesh sieve is greater than 10% by weight, the sample shall be washed; and additional material passing the No. 100 mesh sieve shall be determined by AASHTO Method T 146, except that the No. 100 mesh sieve shall be substituted for the No. 40 mesh sieve where the latter is specified in AASHTO Method T 146. The combined materials that have passed the No. 100 mesh sieve shall not have sufficient plasticity to permit the performing of the plastic limit test using AASHTO Method T 90.

M.05.02—Surface Treatment: Materials for this work shall meet the following requirements:

1. Bituminous Material: The Bituminous materials meet the requirements of M.04. The Asphalt

Emulsion grade shall be as specified in the Contract or as directed by the Engineer.

The type of bituminous material to be used, as well as its viscosity or grade, will depend upon the character and condition of the surface to be treated, the season of the year at which the work is to be done, and will be determined by the Engineer. The Contractor shall not order any material for this work until it has obtained definite instructions from the Engineer as to the asphalt emulsion that is required and as to the type of the bituminous material selected.

2. Sand Cover: Sand shall contain no more than 3% inorganic silt and clay by actual dry weight, using AASHTO Method T 11 and shall meet the following gradation requirements:

Table M.05.02-1

Square Mesh Sieves	Percent Passing by Weight
Pass 1/2 inch	100
Pass 3/8 inch	95-100
Pass No. 4	80-100
Pass No. 50	10-30
Pass No. 100	0-10

SECTION M.12
BEARING AREAS
RIPRAP
SLOPE PAVING & SLOPE PROTECTION
WATERPROOFING AND DAMPPROOFING
STONE AND GRANITE SLOPE CURBING
CALCIUM CHLORIDE FOR DUST CONTROL
WOOD

M.12.01—Bearing Areas:

Prefabricated Pads: Prefabricated pads shall consist of cotton duck impregnated with rubber and shall be a single sheet of 1/8 inch minimum thickness with a tolerance of plus 15% or minus 5%, composed of 8 ounce duck and high quality natural rubber constructed in 5 or more plies. The breakdown stress for compression perpendicular to the plane of lamination shall be not less than 11,000 psi.

M.12.02—Riprap: Materials for this item shall consist of sound, tough, durable and angular rock, free from decomposed stones or other defects impairing its durability. The size of a stone as hereinafter specified shall be its least dimension. Broken concrete or rounded stones are not acceptable. The type of material to be used shall be as noted on the plans, in the special provisions or as may be ordered by the Engineer.

1. **Standard Riprap:** This material shall conform to the following requirements:
   (a) Not more than 15% of the riprap shall be scattered spalls and stones less than 6 inches on any side.
   (b) No stone shall be larger than 30 inches on any side, and at least 75% of the weight shall be stones at least 15 inches.
2. **Intermediate Riprap:** This material shall conform to the following gradation:

Stone Size	% of the weight
18 inches	0
10 to 18 inches	30-50
6 to 10 inches	30-50
4 to 6 inches.	20-30
2 to 4 inches	10-20
less than 2 inches	0-10

3. **Modified Riprap:** This material shall conform to the following gradation:

Stone Size	% of the weight
10 inches	0
6 to 10 inches	20-50
4 to 6 inches	30-60
2 to 4 inches	30-40
1 to 2 inches	10-20
less than 1 inch	0-10

4. **Special Riprap:** The crushed stone shall meet the gradation requirements of Table M.01.02-2 for No. 3 coarse aggregate.

M.12.03—Slope Paving: The stone for this work shall consist of sound, tough, durable rock, free from decomposed stone or other defects impairing its durability. Each piece shall have an area on its exposed surface of not less than 2 s.f. and a thickness not less than 9 inches, except that stone for the 2 bottom rows shall be of such size that they can be embedded at least 2 feet into the ground; and they shall have a thickness of not less than 12 inches.

Concrete slabs shall conform to the dimensions given above for stone, except that the maximum surface dimensions shall not exceed 10 l.f. in any direction.

The concrete materials shall meet the requirements of M.03.01 and M.03.02 for Class PCC0223Z (Slope Paving Concrete).

M.12.04—Waterproofing: The materials for this work shall meet the following requirements:

1. Waterproofing Asphalt: For woven glass fabric, the seal coat material shall be an asphalt conforming to ASTM D449, Type III.

Primer for use with asphalt in waterproofing shall meet the requirements of ASTM D41.

2. Fabric: Woven glass fabric saturated with asphalt shall conform to the requirements of ASTM D1668.

Resin-treated woven glass fabric shall conform to the requirements of ASTM D1668 and shall be compatible for use with asphalt.

3. Mortar: Mortar shall conform to the requirements of M.11.04.

4. Reinforcement: Reinforcement shall meet the requirements of M.06.01.

5. Metal Flashing: Metal flashing shall be of the type and dimensions called for on the plans, and the quality shall be acceptable to the Engineer.

6. Joint Filler: Filler for use in horizontal joints shall be a straight refined petroleum asphalt conforming to the following requirements:

	Min.	**Max.**
Penetration at 77° F, 100 grams, 5 seconds	50	60
Flashpoint, open cup method, in °F	450	
Softening point, in °F	120	130
Loss on heating, at 325° F, 50 grams, 5 hours, %		0.5
Ductility, at 77° F, 5 cm per minute	85	
Total bitumen (Solution in carbon disulfide) %	99.5	

Filler for use in vertical joints shall be an asphalt conforming to above specified requirements, to which has been added 20% by weight of fiber. The incorporation of the fiber with the asphalt shall be done at the factory of the manufacturer to ensure a uniform distribution of the fiber throughout the mix.

M.12.05—Dampproofing: The materials for this work shall meet the following requirements:

Asphalt for Primer: Asphalt for primer shall conform to ASTM D41.

Asphalt for Seal Coat: The asphalt for seal coat shall meet one of the following:

1. Hot-applied asphalt seal coat—ASTM D449, Type 1
2. Cold-applied asphalt seal coat—ASTM D4479, Type 1 (Asbestos Free)
3. Cold-applied emulsified asphalt seal coat—ASTM D1227, Type III or IV

M.12.06—Stone Curbing: The materials for this work shall meet the following requirements:

1. Granite Curbing: Stone for this work shall be hard and durable granite, fundamentally of light color, of general uniform texture, of smooth splitting appearance, free from seams or imperfections that would impair its structural reliability and containing only such color variations as in the judgment of the Engineer would reasonably be characteristic of the material source. The Contractor shall submit for approval, the name of the quarry and the type of curb which the Contractor proposes to use. No stone from any other quarry shall be used unless it has been properly approved.

The finish and surface dimensions for the curb shall conform to the following requirements:

The curbstone shall have a top surface free from wind; it shall be pointed, peen-hammered or sawed to an approximately true plane, and shall have no projections or depressions greater than 1/8 inch. The front and back arris lines shall be pitched straight and true.

On the back surface of the curbstone there shall be no projection for 3 inches down from the top which

would fall outside of a plane having a batter of 4 inches per 12 inches from the back arris line.

The front face shall be at right angles to the plane of the top and shall be smooth quarry-split, free from drill holes in the exposed face. There shall be no projections greater than 3/4 inch, or depressions greater than 1/2 inch, measured from the vertical plane of the face through the top arris line for a distance of 8 inches down from the top. For the remaining distance, there shall be no projections or depressions greater than 1 inch measured in the same manner. The arris lines at the ends shall be pitched with no variation from the plane of the face greater than 1/8 inch.

The ends of all stones shall be square with the planes of the top and face and so finished that, when the stones are placed end to end as closely as possible, no space more than 1/2 inch shall show in the joint for the full width of the top or down on the face for 8 inches. On curbstones having a length of 6 feet or more, the remainder of the end may break back not over 9 inches; whereas, on shorter curbstones, they shall not break back more than 6 inches.

If sawed, the curbstones shall be thoroughly cleaned of any iron rust or iron particles.

Curbstones to be set on a radius of 100 feet or less shall be cut to the curve required, and their ends shall be cut on radial lines. Requirements for length of individual stones in curved curbing vary with radii of curves.

2. Bluestone Curbing: Stone for this work shall be of a good grade, free from structural defects, and shall be approved by the Engineer.

It shall meet the requirements contained hereinbefore for granite curbing, except that the top surface and the top 8 inches of the front face shall be "fine-pointed" in conformity with the requirements of M.11.01 for masonry facing stone.

M.12.07—Granite Slope Curbing: The materials for this work shall meet the following requirements.

1. Granite Slope Curbing: Stone for this work shall be hard and durable granite, fundamentally of light color, of general uniform texture, of smooth-splitting appearance, free from seams or imperfections that would impair its structural reliability and containing only such color variations as, in the judgment of the Engineer, would reasonably be characteristic of the material source. The exposed face of all curbing shall be smooth, quarry-split to an approximate true plane, and shall have no projections or depressions which will cause over 1 inch to show between a 2 foot straightedge and the face when the straightedge is placed as closely as possible on any part of the face. If projections on the face are more than that specified, they shall be dressed off. The top arris line at the face shall be pitched to a line which shall not show over 1 inch in any direction between the stone and a straightedge the full length of the stone. The bottom arris line at the face shall be pitched so that not over 1 inch shall show between the stone and a straightedge, the full length of the stone, when viewed at right angles to the plane of the face. The ends shall be square to the plane of the face and so finished that when the stones are placed end to end as closely as possible, no space more than 1 1/2 inches shall show in the joint for the full width of the face. The arris lines at the ends shall be pitched with no variation from the plane of the face more than 1/4 inch. Drill holes not more than 3 1/2 inches long, not more than 1/2 inch deep, will be permitted. The sides shall not be under the square more than 4 inches or over the square at the back more than 1 inch.

The straight slope curbing shall be in lengths of not less than 2 feet. The curved slope curbing shall be in lengths of at least 6 inches. The curbing shall have a minimum thickness of 3 inches and a maximum thickness of 6 inches.

When the slope curbing is set adjacent to concrete pavement or gutters, the width of the face of the curbing shall be 12 inches, with a tolerance of plus or minus 1/2 inch. When set adjacent to surfaces other than concrete, the curbing finished shall have a face width of not more than 13 inches and not less than 11 inches.

2. Mortar: The mortar for this work shall conform to M.11.04.

3. Gravel Base: The gravel base under the slope curbing shall be granular fill conforming to M.02.03.

M.12.08—Granite Stone Curbing for Bridges: The materials for this work shall conform to the following requirements:

1. Granite Curbing: Stone for this work shall be hard and durable granite, fundamentally of light color, of general uniform texture, of smooth-splitting appearance, free from seams or imperfections that would impair its structural reliability, and containing only such color variations as in the judgment of the Engineer would be reasonably characteristic of the material source. When so directed by the Engineer, the Contractor shall submit samples of the proposed type of curb.

The finish and surface dimensions for the curb shall conform to the requirements shown on the plans.

The ends of all stone shall be jointed square with the planes of the top and face and finished smooth except that, if so noted on plans, the extreme end face of the curbing shall be finished to a radius as shown on the plans.

The minimum length of a stone shall be 4 feet, except that stones of lengths less than 4 feet will be so noted on the plans.

The maximum length of stone to be used on horizontal and vertical curves shall be such as to produce the effect of a smooth, continuous curve. Curbs to be set on a radius of 160 feet or less shall be cut to the curve required, and their ends shall be cut on radial lines.

Detailed cutting plans or schedule shall be submitted for approval of the Engineer prior to cutting stones.

2. Mortar: The mortar for this work shall conform to M.11.04.

3. Metal Anchors: Metal anchors shall be steel conforming to the requirements of M.06.01-1, bar reinforcement, and shall be thoroughly galvanized by the hot-dip process after fabrication.

M.12.09—Vacant

M.12.10—Calcium Chloride for Dust Control: Calcium chloride shall conform to AASHTO M 144, except that the pellet form and the flake form shall be equally acceptable.

M.12.11—Vacant

M.12.12—Concrete Block for Slope Protection: Concrete blocks shall be solid, precast, rectangular blocks 16 inches long, 8 inches wide, and 4 inches thick. No dimensions shall differ from the theoretical block size specified by more than 1/2 inch. The blocks' compressive strength shall be 3,000 psi at 28 days. The concrete mix shall use 3/8 inch (No. 8) or larger coarse aggregate.

M.12.13—Wood: All wood materials for this work shall be manufactured in accordance with AASHTO M 168.

The Contractor shall submit a Materials Certificate in accordance with 1.06.07 or 1.20-1.06.07.

Treatment for wood shall be with a preservative suitable for the conditions of exposure in accordance with AASHTO M 133 and the AWPA Standards U1 and T1. Preservatives shall not be interchanged. End results of treatment, post treatment handling and quality control shall be in accordance with AWPA Standards U1 and T1 for commodities UC4B, UC4C and UC5A, for the type and use specified.

1. Wood in contact with or immersed in water, such as piers, docks, ferry slips, boardwalks, wharves, bridges, etc. shall be one of the following: bongossi, ekki, or azobe, bonalim or greenheart.

Dolphin piles, bulkheads or lead-in jetties shall be one of the following: basralocus greenheart or bongossi, ekki or azobe in order of preference.

2. Wood in contact with the ground such as piles, noise-walls, bulkheads, etc. shall be one of the following: bongossi, ekki or azobe, bonalim, greenheart, pressure treated southern yellow pine, Douglas fir or western larch.

3. Wood in above ground use such as decking, railings, bridges, noise walls and platforms shall be one of the following: bongossi, ekki or azobe, bonalim or greenheart.

Pressure treated wood, where specified shall be No. 1 KD or better southern yellow pine, Douglas fir or western larch. Pressure treated wood shall be stained or painted as specified in the plans or special provisions.