TABLE OF CONTENTS

SECTION 04065

MASONRY MORTAR AND GROUT

PART 1 GENERAL

1.1.1 SUMMARY

A. Section includes mortar and grout for masonry.

B. Related Sections:
1. Section 04810 - Unit Masonry Assemblies: Installation of mortar and grout.
2. Section 04853 - Mortar Placed Stone Assemblies.
3. Section 08115 - Standard Steel Frames.

1.2 REFERENCES

A. ASTM International:
1. ASTM C5 - Standard Specification for Quicklime for Structural Purposes.
2. ASTM C91 - Standard Specification for Masonry Cement.
3. ASTM C94 - Standard Specification for Ready-Mixed Concrete.
4. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic Cement Concrete.
5. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.
6. ASTM C150 - Standard Specification for Portland Cement.
7. ASTM C199 - Standard Test Method for Pier Test for Refractory Mortars.
8. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes.
9. ASTM C270 - Standard Specification for Mortar for Unit Masonry.
10. ASTM C387 - Standard Specification for Packaged, Dry, Combined Materials f or Mortar and Concrete.
11. ASTM C404 - Standard Specification for Aggregates for Masonry Grout.
12. ASTM C476 - Standard Specification for Grout for Masonry.
13. ASTM C595M - Standard Specification for Blended Hydraulic Cements (Metric).
14. ASTM C780 - Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
15. ASTM C1019 - Standard Test Method for Sampling and Testing Grout.
16. ASTM C1142 - Standard Specification for Extended Life Mortar for Unit Masonry.
17. ASTM C1314 - Standard Test Method for Constructing and Testing Masonry Prisms Used to Determine Compliance with Specified Compressive Strength of Masonry.
18. ASTM C1329 - Standard Specification for Mortar Cement.
19. ASTM C1357 - Standard Test Method for Evaluating Masonry Bond Strength.

B. The Masonry Society:
1. TMS MSJC - Building Code for Masonry Structures (ACI 530/ASCE 5/TMS 402), Specification for Masonry Structures (ACI 530.1/ASCE 6/TMS 602) and Commentaries.

1.3 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

B. Samples: Submit two samples of mortar, illustrating mortar color and color range.

C. Design Data: Submit design mix when Property specification of ASTM C270 is to be used, required environmental conditions, and admixture limitations.

D. Test Reports:
1. Submit reports on mortar indicating conformance of mortar to property requirements of ASTM C270 mortar to requirements of ASTM C1142 component mortar materials to requirements of ASTM C270 and test and evaluation reports to ASTM C780 for aggregate ratio and water content, air content, consistency and compressive strength.
2. Submit reports on grout indicating conformance of grout to property requirements of ASTM C476, component grout materials to requirements of ASTM C476 and test and evaluation reports to ASTM C1019.

E. Manufacturer's Installation Instructions: Submit premix mortar manufacturer's installation instructions.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with TMS MSJC Code and TMS MSJC Specification.

B. Maintain one copy of each document on site.

1.5 ENVIRONMENTAL REQUIREMENTS

A. General Requirements: Product requirements.

B. Hot and Cold Weather Requirements: TMS MSJC Specification.

PART 2 PRODUCTS

2.1 MORTAR AND MASONRY GROUT

A. Manufacturer: Any internationally recognized manufacturer having an official technical agreement to conformity with standards for the product.

2.2 COMPONENTS

A. Portland Cement: ASTM C150, Type I, gray color.

B. Mortar Aggregate: ASTM C144, standard masonry type.

C. Grout Aggregate: ASTM C404, fine and/or coarse.

C. Water: Clean and potable.

E. Calcium chloride is not permitted.

2.3 MIXES

A. Mortar Mixes:
1. Mortar for Structural Masonry: ASTM C270, Type M, S, or N, using Proportion specification.
2. Mortar for Non-Structural Masonry: ASTM C270, Type M, S, N, or O, using Proportion specification.
3. Pointing Mortar: ASTM C270, Type N or O, using Proportion specification.
4. Stain Resistant Pointing Mortar: One part Portland cement, 1/8 part hydrated lime, and two parts graded (80 mesh) aggregate, proportioned by volume. Add aluminum tristearate, calcium stearate, or ammonium stearate equal to 2 percent of Portland cement by weight.
5. Mortar for Glass Unit Masonry: ASTM C270, Type S or N, using Proportion specification.
6. Pointing Mortar for Glass Unit Masonry: ASTM C270, Type O, using Proportion specification; with maximum 2 percent ammonium stearate or calcium stearate per cement weight with beach or silica sand aggregate.

B. Mortar Mixing:
1. Thoroughly mix mortar ingredients in accordance with ASTM C270 in quantities needed for immediate use.
2. Achieve uniformly damp sand immediately before mixing process.
3. Add admixtures in accordance with manufacturer's instructions to achieve uniformity of mix and coloration.
4. Re-temper only within two hours of mixing.

C. Grout Mixes:
1. Grout for Non-Structural Masonry: 14 MPa strength at 28 days; 200 to 280 mm slump; mixed in accordance with ASTM C476 fine or coarse grout.
2. Grout for Structural Masonry: 14 MPa strength at 28 days; 200 to 280 mm slump; mixed in accordance with ASTM C476 fine or coarse grout.
3. Application:
   a. Coarse Grout: For grouting spaces with minimum 100 mm dimension in every direction.
   b. Fine Grout: For grouting other spaces.

D. Grout Mixing:
1. Thoroughly mix grout ingredients in quantities needed for immediate use in accordance with ASTM C476.
2. Add admixtures as per manufacturer's instructions and mix uniformly.

PART 3 EXECUTION

3.1 EXAMINATION

A. General Requirements: Administrative requirements for coordination and project conditions.
B. Request inspection of spaces to be grouted.

3.2 PREPARATION

A. Apply bonding agent to existing concrete surfaces in accordance with manufacturer's instructions.

3.3 INSTALLATION

A. Install mortar and grout in accordance with TMS MSJC Specification.

3.4 FIELD QUALITY CONTROL

A. General Requirements: Quality requirements for testing and inspection services, execution requirements for testing, adjusting and balancing.

B. Testing of Mortar Mix: In accordance with ASTM C780 for aggregate ratio and water content, air content, consistency and compressive strength.

C. Testing of Grout Mix: In accordance with ASTM C1019 for compressive strength, and in accordance with ASTM C143/C143M for slump.

D. Test flexural bond strength of mortar and masonry units to ASTM C1357; test in conjunction with masonry unit sections specified.

E. Test compressive strength of mortar and masonry to ASTM C1314; test in accordance with masonry unit sections specified.

3.5 SCHEDULES

A. As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 04810

UNIT MASONRY ASSEMBLIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Concrete masonry units.

B. Related Sections:
1. Section 03200 - Concrete Reinforcement.
2. Section 03300 - Cast-in-Place Concrete.
3. Section 04065 - Masonry Mortar and Grout.
4. Section 04853 - Mortar-Placed Stone Assemblies.
5. Section 05120 - Structural Steel.
6. Section 05500 - Metal Fabrications.
7. Section 07212 - Board Insulation: Insulation for cavity spaces.
8. Section 07260 - Vapor Retarders.
9. Section 07270 - Air Barriers.
10. Section 07620 - Sheet Metal Flashing and Trim.
11. Section 07900 - Joint Sealers.

1.2 REFERENCES

A. ASTM International:
1. ASTM A153/A153M - Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
2. ASTM A580/A580M - Standard Specification for Stainless Steel Wire.
3. ASTM A615/A615M - Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
4. ASTM A641/A641M - Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
5. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by Hot-Dip Process.
6. ASTM A666 - Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
7. ASTM A951 - Standard Specification for Masonry Joint Reinforcement.
8. ASTM B370 - Standard Specification for Copper Sheet and Strip for Building Construction.
9. ASTM C34 - Standard Specification for Structural Clay Load-Bearing Wall Tile.
10. ASTM C55 - Standard Specification for Concrete Brick.
11. ASTM C56 - Standard Specification for Structural Clay Non-Load-Bearing Tile.
12. ASTM C62 - Standard Specification for Building Brick (Solid Masonry Units Made From Clay or Shale).
13. ASTM C67 - Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile.
14. ASTM C73 - Standard Specification for Calcium Silicate Face Brick (Sand-Lime Brick).
15. ASTM C90 - Standard Specification for Loadbearing Concrete Masonry Units.

16. ASTM C126 - Standard Specification for Ceramic Glazed Structural Clay Facing Tile, Facing Brick, and Solid Masonry Units.
17. ASTM C129 - Standard Specification for Nonloadbearing Concrete Masonry Units.
18. ASTM C140 - Standard Test Methods of Sampling and Testing Concrete Masonry Units.
19. ASTM C150 - Standard Specification for Portland Cement.
20. ASTM C212 - Standard Specification for Structural Clay Facing Tile.
21. ASTM C216 - Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale).
22. ASTM C315 - Standard Specification for Clay Flue Linings.
23. ASTM C530 - Standard Specification for Structural Clay Non-Loadbearing Screen Tile.
24. ASTM C652 - Standard Specification for Hollow Brick (Hollow Masonry Units Made From Clay or Shale).
25. ASTM C744 - Standard Specification for Prefaced Concrete and Calcium Silicate Masonry Units.
26. ASTM C1261 - Standard Specification for Firebox Brick for Residential Fireplaces.
27. ASTM D226 - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.

B. The Masonry Society:
1. TMS MSJC - Building Code for Masonry Structures (ACI 530/ASCE 5/TMS 402), Specification for Masonry Structures (ACI 530.1/ASCE 6/TMS 602) and Commentaries.

1.3 PERFORMANCE REQUIREMENTS FOR PARTITIONS

A. Construction details:
1. Walls shall be built from structural floor to underside of the structural soffit.
2. The cavity between the two wall leaves shall not be bridged, except by means of butterfly wall ties.
3. The separating wall shall have no chases or sockets cut into it.
4. Vertical and horizontal joints within blocks and between blockwork and other constructions shall be filled with mortar to full the depth of the blockwork. There shall be no cavities or holes in the mortar.
5. Where builders work holes are to be created, the Contractor shall ensure that the opening is finished no greater than 50 mm from the service penetration. It must be ensured that the penetration is suitably sealed in order that the acoustic performance of the wall construction is not degraded.
6. Following award of Tender, the Contractor shall submit to the Engineer for approval, all necessary shop drawings of proposed construction details, including all necessary stiffening columns, tie beams, lintels, jambs and sills for masonry, service penetrations, etc.

1.4 SEISMIC REQUIREMENTS

A. Masonry walls shall comply with Uniform Building Code (UBC) 1997 requirements as concerns resistance to seismic forces and shall have at least the descriptions stated in these Specifications and shown on the Drawings.

1.5 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

B. Product Data: Submit data for concrete masonry units and fabricated wire reinforcement, wall ties, anchors and all other accessories.

B. Samples: Submit four samples of concrete masonry units to illustrate color, texture and extremes of color range.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with TMS MSJC Code and TMS MSJC Specification.

B. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

A. Installer: Company specializing in performing Work of this section with minimum five years documented experience.

1.8 MOCKUP

A. General Requirements: Quality requirements for mockup.

B. Construct masonry wall mockup into a panel sized 2800 x 2000 mm high complete including masonry, mortar, accessories, structural backup, wall openings, flashings, wall insulation, air barrier, vapor retarder, parging and all other related items.

C. Locate where directed by the Engineer.

D. Remove mockup where directed by the Engineer.

1.9 PRE-INSTALLATION MEETINGS

A. General Requirements: Administrative requirements for pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.10 DELIVERY, STORAGE AND HANDLING

A. General Requirements: Product requirements for product storage and handling.

B. Accept concrete masonry units on site. Inspect for damage.

1.11 ENVIRONMENTAL REQUIREMENTS

A. General Requirements: Product requirements.

B. Hot and Cold Weather Requirements: TMS MSJC Specification.

1.12 COORDINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Coordinate masonry work with stone cut veneer, installation of window and door anchors.

1.13 EXTRA MATERIALS

A. General Requirements: Execution requirements for spare parts and maintenance products.

B. Supply 50 of each size, color and type of all units.

PART 2 PRODUCTS

2.1 UNIT MASONRY ASSEMBLIES

A. Manufacturer: Any internationally recognized manufacturer having an official technical agreement to conformity with standards for the product.

2.2 COMPONENTS

A. Hollow or Solid Load-Bearing or Non-Load Bearing Concrete Masonry Units: To ASTM C90 or ASTM C129, Type I - Moisture Controlled, or Type II - Non-moisture Controlled; normal, medium, or light weight.
   1. Size and Shape: Of nominal modular size as shown on drawings, or as directed by the Engineer. Furnish special units for 90º corners, bond beams, lintels, coved base and bullnosed corners.

2.3 ACCESSORIES

A. Single Wythe Joint Reinforcement: Truss and/or ladder type; stainless steel type 316, conforming to ASTM A580/A580M, 4.8 mm side rods.

B. Multiple Wythe Joint Reinforcement: Truss or ladder type; with moisture drip; adjustable type, stainless steel type 316, to ASTM A580/A580M, 4.8 mm side rods.

C. Reinforcing Steel: As specified in section 03200.

D. Head Restraints: Austenitic stainless steel Ancon Head Restraints Type IHR-V or approved equal.

E. Strap Anchors: Hot dip galvanized to ASTM A153/A153M "B2" finish.

F. Wall Ties: Corrugated formed sheet metal, hot dip galvanized to ASTM A153/A153M "B2" finish.

G. Wall Ties: Formed steel wire, adjustable and/or eye and pintle type, hot dip galvanized to ASTM A153/A153M "B2" finish.

H. Dovetail Anchors: Bent steel strap, galvanized to ASTM A153/A153M "B2" finish.

I. Anchor Bolts: Headed, J-shaped or L-shaped.

J. Mortar and Grout: As specified in Section 04065.

K. Stainless Steel: ASTM A666, Type 316, soft temper, smooth finish.

L. Lap Sealant: As specified in Section 07900.

M. Preformed Control Joints: Rubber, neoprene or polyvinyl chloride material. Furnish with corner and tee accessories, and fused joints.

N. Joint Filler: Closed cell polyvinyl chloride, polyethylene, polyurethane and/or rubber; oversized 50 percent to joint width; self expanding.

O. Building Paper: ASTM D226, No. 15 or 30, asphalt saturated felt.

P. Nailing Strips: Softwood, preservative treated for moisture resistance, dovetail shape, sized to masonry joints.

Q. Weeps: Preformed plastic tubes cotton wick filled and/or hollow, vents with sloping louvers, and/or cotton rope.

R. Cavity Vents: Molded polyvinyl chloride grilles and/or Aluminum; insect resistant.

S. Chimney Cap: Precast concrete, sized to cover chimney construction plus additional overhang for drip on four sides, slope from flue opening to edges for natural drainage.

T. Cleaning Solution: Non-acidic, not harmful to masonry work or adjacent materials.

U. Precast or Cast-in-situ Reinforced Concrete Lintels: Concrete shall be using Ordinary Portland cement to ASTM C150, Type I, 25 MPa strength at 28 days, and as specified in Section 03300; size as indicated on Drawings.

V. Steel Lintels (if any): Size as indicated on Drawings, hot-dip galvanized.

PART 3 EXECUTION

3.1 EXAMINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Verify field conditions are acceptable and are ready to receive work.

C. Verify items provided by other sections of work are properly sized and located.

D. Verify built-in items are in proper location, and ready for roughing into masonry work.

3.2 PREPARATION

A. Direct and coordinate placement of metal anchors supplied to other sections.

B. Furnish temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent support.

3.3 INSTALLATION

A. Establish lines, levels and coursing indicated. Protect from displacement.

B. Maintain masonry courses to uniform dimension. Form bed and head joints of uniform thickness.

C. Coursing of Concrete Masonry Units:
1. Bond: Running or stacked.
2. Coursing: One unit and one mortar joint to equal 200 mm.
3. Mortar Joints: Concave, raked, flush or beveled.

D. Placing and Bonding:
1. Lay solid masonry units in full bed of mortar, with full head joints.
2. Lay hollow masonry units with face shell bedding on head and bed joints.
3. Buttering corners of joints or excessive furrowing of mortar joints are not permitted.
4. Remove excess mortar as work progresses.
5. Interlock intersections and external corners.
6. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment is required, remove mortar and replace.
7. Perform job site cutting of masonry units with proper tools to assure straight, clean, unchipped edges. Prevent broken masonry unit corners or edges.
8. Cut mortar joints flush where wall tile is scheduled, cement parging is required, resilient base is scheduled, cavity insulation vapor barrier adhesive is applied, or bitumen dampproofing is applied.
9. Isolate masonry from vertical structural framing members with movement joint as indicated on Drawings and/or as directed by the Engineer.
10. Isolate top of masonry from horizontal structural framing members and slabs or decks with compressible joint filler.

E. Weeps and Vents: Furnish weeps and vents in outer wythe at 600 and/or 800 mm oc horizontally above through-wall flashing, above shelf angles and lintels, and/or at bottom of walls.

F. Cavity Wall: Do not permit mortar to drop or accumulate into cavity air space or to plug weeps. Build inner wythe ahead of outer wythe to receive cavity insulation and air/vapor barrier adhesive.

G. Joint Reinforcement and Anchorage - Single Wythe Masonry:
1. Install horizontal joint reinforcement 400 mm oc.

2. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 400 mm each side of opening.
3. Place joint reinforcement continuous in 1st and 2nd joint below top of walls.
4. Lap joint reinforcement ends minimum 150 mm.
5. Reinforce stack bonded unit joint corners and intersections with strap anchors 400 mm oc.

H. Joint Reinforcement and Anchorage - Masonry Veneer:
1. Install horizontal joint reinforcement 400 mm oc.
2. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 400 mm each side of opening.
3. Place joint reinforcement continuous in 1st and 2nd joint below top of walls.
4. Lap joint reinforcement ends minimum 150 mm.
5. Embed wall ties in masonry backing to bond veneer for every 0.25m². Place at maximum 75mm oc each way around perimeter of openings, within 300mm of openings.
6. Coordinate following with typical stud spacing of 16 or 24 inch oc.
7. Secure wall ties and rod or strap anchors to stud framed backing and embed into masonry veneer at maximum 400 mm oc vertically and 900 mm oc horizontally. Place at maximum 75 mm oc each way around perimeter of openings, within 300 mm of openings.
8. Reinforce stack bonded unit joint corners and intersections with strap anchors 400 mm oc.

I. Joint Reinforcement and Anchorages - Cavity Wall Masonry:
1. Install horizontal joint reinforcement 400 mm oc.
2. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 400 mm each side of opening.
3. Place joint reinforcement continuous in 1st and 2nd joint below top of walls.
4. Lap joint reinforcement ends minimum 150 mm.
5. Embed anchors in concrete. Attach to structural steel members.
6. Reinforce stack bonded unit joint corners and intersections with strap anchors 400 mm oc.

J. Reinforcement and Anchorages - Multiple Wythe Unit Masonry:
1. Install horizontal joint reinforcement 400 mm oc.
2. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 400 mm each side of opening.
3. Place joint reinforcement continuous in 1st and 2nd joint below top of walls.
4. Lap joint reinforcement ends minimum 150 mm.
5. Support and secure reinforcing bars from displacement. Maintain position within 13 mm of dimensioned position.
6. Embed anchors embedded in concrete or attached to structural steel members. Embed anchorages in every second block and/or sixth brick joint.
7. Reinforce stack bonded unit joint corners and intersections with strap anchors 400 mm oc.

K. Masonry Flashings:
1. Extend flashings horizontally through outer wythe at foundation walls, above ledge or shelf angles and lintels, under parapet caps, and/or at bottom of walls, and turn down on outside face to form drip.

2. Turn flashing up minimum 200 mm and bed into mortar joint of masonry, seal to concrete, or to sheathing over wood, steel stud or framed backing.
3. Lap end joints minimum 150 mm and seal watertight.
4. Turn flashing, fold, and seal at corners, bends, and interruptions.

L. Lintels:
1. Install loose steel or precast or cast-in-situ concrete lintels over openings.
2. Reinforcing bars for lintels shall be as indicated on drawings.
3. Do not splice reinforcing bars.
4. Support and secure reinforcing bars from displacement.
5. Place and consolidate grout fill without displacing reinforcing.
6. Allow lintels to attain the specified strength before removing temporary supports.
7. Bearing on each side of opening shall be as indicated on drawings, but in no case shall be less than 200 mm.

M. Grouted Components:
1. Reinforce bond beam as indicated on drawings.
2. Lap splices bar diameters required by code.
3. Support and secure reinforcing bars from displacement.
4. Place and consolidate grout fill without displacing reinforcing.
5. At bearing locations, fill masonry cores with grout for minimum 300 mm both sides of opening.

N. Reinforced Masonry:
1. Lay masonry units with core and/or cells vertically aligned and cavities between wythes clear of mortar and unobstructed.
2. Place reinforcement bars as indicated on Drawings.
3. Splice reinforcement in accordance with Section 03200.
4. Support and secure reinforcement from displacement.
5. Place and consolidate grout fill without displacing reinforcing.
6. Place grout in accordance with TMS MSJC Specification.

O. Control and Expansion Joints:
1. Do not continue horizontal joint reinforcement through control and expansion joints.
2. Install preformed control joint device in continuous lengths. Seal butt corner joints.
3. Size control joint in accordance with Section 07900 for sealant performance.
4. Form expansion joint by omitting mortar and cutting unit to form open space.

P. Built-In Work:
1. As work progresses, install built-in metal door and/or glazed frames, fabricated metal frames, window frames, wood nailing strips, fireplace accessories, anchor bolts, plates, and all other items to be built in the work and furnished by other sections.
2. Install built-in items plumb and level.
3. Bed anchors of metal door and/or glazed frames in adjacent mortar joints. Fill frame voids solid with grout or mortar. Fill adjacent masonry cores with grout minimum 300 mm from framed openings.
4. Do not build in materials subject to deterioration.

Q. Cutting and Fitting:
   1. Cut and fit for chases, pipes, conduit, sleeves, grounds, etc. Coordinate with other sections of work to provide correct size, shape and location.
   2. Obtain Engineer's approval prior to cutting or fitting masonry work not indicated or where appearance or strength of masonry work may be impaired.

R. Parging:
   1. Dampen masonry walls prior to parging.
   2. Scarify each parging coat to ensure full bond to subsequent coat.
   3. Parge masonry walls in two uniform coats of mortar to 19 mm total thickness.
   4. Steel trowel surface smooth/flat with maximum surface variation of 1mm/m.
   5. Strike top edge of parging at 45º.

S. Install Work in accordance with the drawings, to the manufacturer's instructions and to the approval of the Engineer.

3.4 ERECTION TOLERANCES

A. General Requirements: Quality requirements for tolerances.

B. Maximum Variation from Alignment of Columns: 6 mm.

C. Maximum Variation from Unit to Adjacent Unit: 1.6 mm.

D. Maximum Variation from Plane of Wall: 6 mm/3 m and 13 mm/6 m or more.

E. Maximum Variation from Plumb: 6 mm per story non-cumulative; 13 mm in two stories or more.

F. Maximum Variation from Level Coursing: 3 mm/m and 6 mm/3 m; 13 mm/9 m.

G. Maximum Variation of Joint Thickness: 3 mm/m.

H. Maximum Variation from Cross Sectional Thickness of Walls: 6 mm.

I. Maximum Variation for Steel Reinforcement:
   1. Plus or minus 13 mm when distance from centerline of steel to opposite face of masonry is 200 mm or less.
   2. Plus or minus 25 mm when distance is between 200 and 600 mm.
   3. Plus or minus 32 mm when distance is greater than 600 mm.
   4. Plus or minus 50 mm from location along face of wall.

3.5 FIELD QUALITY CONTROL

A. General Requirements: Quality requirements for testing and inspection services, and execution requirements for testing, adjusting and balancing.
B. Concrete Masonry Units: Test each type in accordance with ASTM C140.

3.6 CLEANING

A. General Requirements: Execution requirements for final cleaning.

B. Remove excess mortar and mortar smears as work progresses.

C. Replace defective mortar. Match adjacent work.

D. Clean soiled surfaces with cleaning solution.

E. Use non-metallic tools in cleaning operations.

3.7 SCHEDULES

As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 04852

METAL-SUPPORTED STONE ASSEMBLIES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes stone veneer at exterior and interior walls, columns, beams and parapets; metal anchors and supports; and joint sealing and pointing.

B. Related Sections:
1. Section 05120 - Structural Steel: Structural steel framing members supporting stone.
2. Section 05500 - Metal Fabrications: Shelf angles and supports and metal fabricated items for building into cut stone.
3. Section 07620 - Sheet Metal Flashing and Trim: Coping, lintel, and sill flashings.
4. Section 07900 - Joint Sealers: Sealant for panel unit, perimeter, control and expansion joints.

1.2 REFERENCES

A. ASTM International:
1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
2. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
3. ASTM A666 - Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar.
4. ASTM C503 - Standard Specification for Marble Dimension Stone (Exterior)
5. ASTM C568 - Standard Specification for Limestone Dimension Stone.
6. ASTM C615 - Standard Specification for Granite Dimension Stone.
7. ASTM C616 - Standard Specification for Quartz-Based Dimension Stone.
8. ASTM C629 - Standard Specification for Slate Dimension Stone.

B. The Masonry Society:
1. TMS MSJC - Building Code for Masonry Structures (ACI 530/ASCE 5/TMS 402), Specification for Masonry Structures (ACI 530.1/ASCE 6/TMS 602) and Commentaries.

C. Marble Institute of America:
1. MIA - Dimension Stone Manual.

1.3 DESIGN REQUIREMENTS

A. Design anchors and supports under direct supervision of a Professional Engineer, experienced and licensed in design of this Work.

B. Design anchors to resist positive and negative wind pressures and other loads as required by applicable codes.

C. Design anchor attachment to stone with factor of safety of (5:1).

D. Design each individual anchor with factor of safety in vertical dead-load-bearing direction of (4:1) and in horizontal lateral-load-bearing direction of (2:1).

1.4 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

B. Shop Drawings: Indicate layout, pertinent dimensions, anchorages, head, jamb, and sill opening details, control and expansion jointing methods. Include loads transferred to building structural system.

C. Product Data: Submit data on stone units, anchors, mortar products and sealants.

D. Design Data: Submit design calculations.

E. Samples:
1. Submit two stone samples of area not less than 0.10 m^2 each, illustrating general color range and texture, markings and surface finish.
2. Samples: Submit mortar color samples.
3. Samples: Submit anchor samples.

F. Manufacturer's Installation Instructions: Submit stone fabricator's installation instructions and field erection or setting drawings. Indicate panel identifying marks and locations on setting drawings.

1.5 QUALITY ASSURANCE

A. Perform work in accordance with MIA Dimensional Stone Design Manual. Maintain one copy of document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum ten years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum five years documented experience.

1.7 MOCKUP

A. General Requirements: Quality requirements for mockup.

B. Construct stone wall mock-up, size as directed by the Engineer, including stone, stone anchor accessories, sill and head flashings, sealants, window frame, and control joint.

C. Locate where directed by the Engineer.

D. Remove mockup when directed by the Engineer.

1.8 PRE-INSTALLATION MEETINGS

A. General Requirements: Administrative requirements for pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

A. General Requirements: Product requirements for product storage and handling.

B. Store stone panels vertically on edge, resting weight on panel edge.

C. Protect stone from discoloration during storage on site.

D. Provide ventilation to prevent condensation from forming on stone.

1.10 ENVIRONMENTAL REQUIREMENTS

A. Product conditions affecting products.

B. Hot and Cold Weather Requirements: MSJC Specification.

1.11 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.12 STONE TESTING

A. Stone testing shall be carried out to assess compressive strength (BSEN 1926) density/porosity (BSEN 1936) water absorption (BSEN 1925) resistance to salt crystallization (BSEN 12370) and specification flexural strength (BSEN 12372).

B. Small samples shall be provided as required by the Design Team, including range samples for stone.

1.13 IMPACT TESTING

A. Impact testing shall be carried out in accordance with relevant ASTM Standards to demonstrate compliance with the performance specifications. The Mock-up can be used for this purpose.

B. Soft body impact tests shall be carried out on the test sample. Impact energies shall be in accordance with the relevant Standards.

C. For each mock-up, the following points shall be impacted:
1. the center of the stone with the largest area.
2. the center of the stone with the large aspect ratio (the ratio of the long side to the short side).
3. the center of the longest horizontal edge.
4. the center of the longest vertical edge.
5. three number four way junctions.

D. For the safety impact test, each location shall be struck once. When subjected to the safety impact energies specified, the structural safety of the structural framework shall not be put at risk, and no pieces of the stonework shall fall out or become completely detached from their supporting fixings. In addition, the soft body shall not pass through the stonework.

E. For the serviceability impact test, each location shall be struck three times. When subjected to the serviceability impact energies, the stone shall not crack or break.

PART 2 PRODUCTS

2.1 METAL SUPPORTED STONE ASSEMBLIES

A. Manufacturer: Any internationally recognized manufacturer having an official technical agreement to conformity with standards for the product.

2.2 COMPONENTS

A. Marble: Complying with ASTM C503 Classification I - Calcite, Classification II - Dolomite, Classification III - Serpentine, and/or Classification IV - Travertine.
1. Grade: As indicated on drawings.
2. Color: As indicated on drawings.
3. Surface: Filled and/or unfilled, as indicated on drawings.
4. Surface Texture: Polished unless otherwise indicated on drawings.

B. Granite: Type as shown on drawings; complying with ASTM C615.
1. Grade: As indicated on drawings.
2. Color: As indicated on drawings.
3. Surface Texture: Polished unless otherwise indicated on drawings.

C. Stone: Type as indicated on drawings.
1. Grade: As indicated on drawings.
2. Color: As indicated on drawings.
3. Surface Texture: As indicated on drawings.

2.3 ACCESSORIES

A. Anchors & Components in Contact with Stone: ASTM A666 stainless steel type 316.

B. Sizes and configurations: As required for vertical and horizontal support of stone and applicable loads. Wire ties are not permitted.

C. Support Components not in Contact with Stone: ASTM A666 stainless steel type 316.

D. Setting Buttons and Shims: Lead or plastic type.

E. Flashings: As specified in Section 07620.

F. Cavity Vents: As indicated on drawings.

G. Weeps: As indicated on drawings.

H. Joint Filler: Closed cell foam type unless otherwise indicated on drawings.

I. Bond Breaker: 0.25 mm thick plastic sheet unless otherwise indicated on drawings.

J. Sealant: As specified in Section 07900; Color to match stone color.

K. Damp-Proofing: Bituminous.

L. Isolating Non-Conductive Materials between Dissimilar Metals: As specified in Section 05500.

M. Cleaning Solution: Non-acid; not harmful to stone, joint materials & adjacent surfaces

2.4 FABRICATION

A. Thickness: As indicated on drawings.

B. Panel Size: As indicated on drawings.

C. Fabricate units with uniform coloration between adjacent units and over full area.

D. Form external corners to square joint profile.

E. Slope exposed top surfaces of stone and horizontal sill surfaces for natural wash.

F. Cut drip slot in bottom surface of work Projecting more than 13 mm over window frame. Size slot not less than 10 mm wide and 6 mm deep; full width of Projection.

2.5 FABRICATION TOLERANCES

Fabrication Tolerances: In accordance with MIA Specifications.

PART 3 EXECUTION

3.1 EXAMINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Verify support work and site conditions are ready to receive work of this section.

C. Verify items built-in under other sections are properly located and sized.

3.2 PREPARATION

A. Establish lines, levels and coursing. Protect from disturbance.

B. Clean interior stone prior to erection. Do not use wire brushes or implements that

mark or damage exposed surfaces.

C. Coat back surfaces with damp-proofing prior to setting. Allow coating to cure.

3.3 INSTALLATION

A. Install flashings of longest practical length and seal watertight to back-up. Lap end joint minimum 150 mm and seal watertight.

B. Erect stone in accordance with erection or setting drawings.

C. Set stone with a consistent joint width as indicated on drawings.

D. Obtain Engineer's approval prior to cutting or fitting item not indicated or where appearance or strength of stone work may be impaired.

E. Install anchors and setting buttons to support stone and to establish joint dimensions.

F. Install isolating non-conductive materials between dissimilar metals as per approved methodology.

G. Install cavity vents horizontally at top of each cavity space, below shelf angles, and/or where and as indicated on drawings.

H. Install weeps in vertical stone joints horizontally; immediately above horizontal flashings, above shelf angles and supports, at bottom of walls, and/or where and as indicated on drawings. Do not permit mortar accumulation in cavity space.

I. If required, fill joints with pointing mortar. Pack and work into voids. Neatly tool surface to concave and/or raked joint.

J. Seal joints indicated with sealant. Perform sealant work in accordance with requirements of Section 07900.

K. Over the lowest 3m, stone system shall incorporate additional pressure pads in contact with the internal face of the stone or shall be filled with cement grout with an approved waterproofing detail at top.

L. Install Work in accordance with the drawings, to the manufacturer's instructions and to the approval of the Engineer.

3.4 ERECTION TOLERANCES

A. General Requirements: Quality requirements for tolerances.

B. Positioning of Elements: Maximum 6 mm from indicated position.

C. Maximum Variation from Plane of Wall: 6 mm in 3 m; 13 mm in 15 m.

D. Maximum Variation between Face Planes of Adjacent Panels: 1.5 mm.

E. Maximum Variation from Plumb: 6 mm per story non-cumulative.

F. Maximum Variation from Level Coursing: 3 mm/m; 6 mm in 3 m; 13 mm maximum.

G. Maximum Variation of Joint Thickness: 3 mm/m.

3.5 CLEANING

A. General Requirements: Execution requirements for final cleaning.

B. Remove excess mortar and sealant as work progresses, and upon completion of work.

C. Clean soiled surfaces with non-acid cleaning solution.

D. Use non-metallic tools in cleaning operations.

3.6 PROTECTION OF INSTALLED CONSTRUCTION

A. General Requirements: Execution requirements for protecting installed construction.

B. During temporary storage on site, at end of working day, and during rainy weather, cover stone work exposed to weather with non-staining waterproof coverings, securely anchored.

3.7 SCHEDULES

A. As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 04853

MORTAR-PLACED STONE ASSEMBLIES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes stone veneer at exterior and interior walls, columns, beams and parapets; metal anchors and accessories; and mortar and joint pointing.

B. Related Sections:
1. Section 04065 - Masonry Mortar and Grout: Bedding and pointing mortar.
2. Section 04810 - Unit Masonry Assemblies: Horizontal Joint Reinforcement.
3. Section 05500 - Metal Fabrications: Product requirements for metal fabricated items for building into stone masonry for placement by this section.
4. Section 07620 - Sheet Metal Flashing and Trim: Product requirements for sheet metal coping and sill flashings for placement by this section.
5. Section 07900 - Joint Sealers: Sealant for perimeter, control, and expansion joints.

1.2 REFERENCES

A. ASTM International:
1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
2. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
3. ASTM A580/A580M - Standard Specification for Stainless Steel Wire.
4. ASTM A666 - Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
5. ASTM C503 - Standard Specification for Marble Dimension Stone (Exterior)
6. ASTM C568 - Standard Specification for Limestone Dimension Stone.
7. ASTM C615 - Standard Specification for Granite Dimension Stone.
8. ASTM C902 - Standard Specification for Pedestrian and Light Traffic Paving Brick.

B. The Masonry Society:
1. TMS MSJC - Building Code for Masonry Structures (ACI 530/ASCE 5/TMS 402), Specification for Masonry Structures (ACI 530.1/ASCE 6/TMS 602) and Commentaries.

1.3 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

B. Product Data: Submit data on stone units, mortar products, reinforcement, wall tiles, anchors and flashings.

C. Samples:
1. Submit two samples of each type of stone illustrating minimum and maximum stone sizes, general color range and texture and markings.

2. Submit mortar color samples.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum ten years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum five years documented experience.

1.5 MOCKUP

A. General Requirements: Quality requirements for mockup.

B. Construct stone wall mockup, size as directed by the Engineer, complete including stone, reinforcing, wall ties, mortar, sill and head flashings, window frame and control joint.

C. Locate where directed by the Engineer.

D. Remove mockup when directed by the Engineer.

1.6 PRE-INSTALLATION MEETINGS

A. General Requirements: Administrative requirements for pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE AND HANDLING

A. General Requirements: Product requirements for product storage and handling.

B. Protect stone from discoloration during storage on site.

C. Provide ventilation to prevent condensation from forming on stone.

1.8 ENVIRONMENTAL REQUIREMENTS

A. General Requirements: Product requirements.

B. Hot and Cold Weather Requirements: TMS MSJC Specification.

PART 2 PRODUCTS

2.1 MORTAR PLACED STONE ASSEMBLIES

A. Manufacturer: Any internationally recognized manufacturer having an official technical agreement to conformity with standards for the product.

2.2 COMPONENTS

A. Limestone: Complying with ASTM C568 Classification I - Low Density and/or Classification II - Medium Density.

B. Marble: Complying with ASTM C503, Classification I - Calcite, Classification II - Dolomite, Classification III - Serpentine, and/or Classification IV - Travertine.

C. Granite: Complying with ASTM C615.

D. Stone: Type as indicated on drawings.

E. Brick: To ASTM C902, weather class, type and application to suit the project; and to the following characteristics:
   1. Type, Size and Shape: As indicated on drawings.
   2. Color: As selected by the Engineer.
   3. Exposed Surface Texture: As selected by the Engineer.

F. Surface Texture: As indicated on drawings.

G. Grade: As indicated on drawings.

H. Color: As indicated on drawings.

I. Mortar and Grout: As specified in Section 04065.

2.3 ACCESSORIES

A. Horizontal Joint Reinforcement: As specified in Section 04810.

B. Wall Ties: stainless steel type 316, conforming to ASTM A580/A580M, eye and pintle type, wall strap for bolted attachment to studs, wire loop for embedment in back-up masonry, with provision for vertical adjustment after attachment.

C. Other Anchors in Direct Contact with Stone: ASTM A666, stainless steel type 316, of sizes and configurations required for support of stone and applicable superimposed loads.

D. Setting Buttons and Shims: Lead, and/or Plastic.

E. Flashings: Specified in Section 07620.

F. Cavity Vents: Polyethylene tubing, 6 mm diameter.

G. Weeps: Polyethylene tubing, 6 mm diameter; Open head joints.

H. Joint Filler: Closed cell foam type.

I. Bond Breaker: 0.25 mm thick plastic sheet.

J. Dampproofing: Bituminous.

K. Cleaning Solution: Non-acid, not harmful to stone, joint materials, or adjacent surfaces.

2.4 FABRICATION

A. Nominal Thickness: As indicated on drawings.

B. Nominal Face Size: As indicated on drawings.

C. Pattern and Coursing: As indicated on drawings.

D. Fabricate for 10 mm beds and joints.

E. Bed and Joint Surfaces: Cut or sawn full square for full thickness of unit.

F. Backs: Sawn, and/or Rough or split.

G. Form stone corners to irregular joint profile. Clean jagged corners from stone in preparation for setting.

H. Slope exposed top surfaces of stone and horizontal sill surfaces for shedding water.

I. Cut drip slot in bottom surface of work Projecting more than 13 mm over window frame. Size slot not less than 10 mm wide and 6 mm deep for full width of Projection.

PART 3 EXECUTION

3.1 EXAMINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Verify support work and site conditions are ready to receive work of this section.

C. Verify items built-in under other sections are properly located and sized.

3.2 PREPARATION

A. Establish lines, levels, and coursing. Protect from disturbance.

B. Clean interior stone prior to erection. Do not use wire brushes or implements that mark or damage exposed surfaces.

C. Coat back surfaces with dampproofing prior to setting. Allow coating to cure.

D. Clean sawn surfaces of rust stains and iron particles.

3.3 INSTALLATION

A. Install flashings of longest practical length and seal watertight to back-up. Lap end

joints minimum 150 mm and seal watertight.

B. Cut and/or Split stone at site to produce clean faces.

C. Size stone units to fit opening dimensions and perimeter conditions.

D. Wet absorptive stone in preparation for placement to minimize moisture suction from mortar.

E. Arrange stone pattern in color uniformity and minimize visual variations.

F. Install setting bed and pointing mortar in accordance with Section 04065.

G. Fill dowel holes in stone units with mortar and/or non-expanding grout.

H. Arrange stone coursing in running and/or stack bond with consistent joint width.

I. Set stone in full mortar setting bed to fully support stone over bearing surface. Use setting buttons or shims to maintain correct joint width.

J. Reinforcement and Anchorage:
1. Install horizontal joint reinforcement 400 mm oc.
2. Place horizontal joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 400 mm each side of opening.
3. Place joint reinforcement continuous in first and second joint below top of walls.
4. Lap joint reinforcement ends minimum 150 mm.
5. Embed wall ties in masonry backing and/or attach wall ties to back-up to bond veneer to back-up at minimum of one for every 0.25 sq m.
6. In addition, place wall ties at maximum 75 mm oc each way around perimeter of openings, within 300 mm of openings.
7. Reinforce stack bonded unit joint corners and intersections with strap anchors 400 mm oc.

K. Joints:
1. Rake out mortar joints 16 to 19 mm and brush joints clean to accommodate pointing mortar. Fill joints with pointing mortar.
2. Pack mortar into joints and work into voids. Neatly tool surface to concave and/or raked joint.
3. At joints to be sealed, clean mortar out of joint before mortar sets. Brush joints clean.
4. Seal joints indicated with sealant. Perform sealant work in accordance with requirements of Section 07900.

L. Accessories:
1. Install cavity vents horizontally at top of each cavity space, below shelf angles, and/or as indicated on drawings.
2. Install weeps in vertical stone joints horizontally; immediately above horizontal flashings, above shelf angles and supports, at bottom of walls, and/or as indicated on drawings. Do not permit mortar accumulation in cavity space.

M. Install Work in accordance with the drawings, to the manufacturer's instructions and to the approval of the Engineer.

3.4 FIELD QUALITY CONTROL

A. General Requirements: Quality requirements for testing and inspection services, and execution requirements for testing, adjusting and balancing.

B. Testing of Mortar and Grout: In accordance with Section 04065.

3.5 CLEANING

A. General Requirements: Execution requirements for final cleaning.

B. Remove excess mortar as work progresses, and upon completion of work.

C. Clean soiled surfaces with non-acid cleaning solution.

D. Use non-metallic tools in cleaning operations.

3.6 PROTECTION OF INSTALLED CONSTRUCTION

A. General Requirements: Execution requirements for protecting installed construction.

B. During temporary storage on site, at end of working day, and during rainy weather, cover stone work exposed to weather with non-staining waterproof coverings, securely anchored.

3.7 SCHEDULES

A. As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 05120

STRUCTURAL STEEL

PART 1 GENERAL

1.1 SUMMARY

A. Section includes structural steel framing members, support members, suspension cables, sag rods, and struts; base or bearing plates, shear stud connectors, and expansion joint plates; anchor bolts for structural steel; beams, girders, purlins, and girts; bearing of steel for girders, trusses or bridges; bracing; columns, posts; connecting materials for framing structural steel to structural steel; crane rails, splices, stops, bolts, and clamps; door frames constituting part of structural steel frame; expansion joints connected to structural steel frame; fasteners for connecting structural steel items; permanent shop bolts; shop bolts for shipment; field bolts for permanent connections; permanent pins; floor plates (checkered or plain) attached to structural steel frame; grillage beams and girders; hangers essential to structural steel frame; leveling plates, wedges, shims, and leveling screws; lintels, when attached to structural steel frame; trusses; and grouting under base plates.

B. Related Sections:
1. Section 04065 - Masonry Mortar and Grout.
2. Section 05500 - Metal Fabrications.

1.2 REFERENCES (*Equivalent Equal Acceptable*)

A. American Institute of Steel Construction:
1. AISC S303 - Code of Standard Practice for Steel Buildings and Bridges.

B. ASTM International:
1. ASTM A6/A6M - Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
2. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
3. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
4. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
5. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
6. ASTM A242/A242M - Standard Specification for High-Strength Low-Alloy Structural Steel.
7. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength.
8. ASTM A325M - Standard Specification for High-Strength Bolts for Structural Steel Joints (Metric).
9. ASTM A449 - Standard Specification for Quenched and Tempered Steel Bolts and Studs.
10. ASTM A490M - Standard Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric).
11. ASTM A500 - Standard Specification for Cold-Formed Welded and

Seamless Carbon Steel Structural Tubing in Rounds and Shapes.

12. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
13. ASTM A514/A514M - Standard Specification for High-Yield-Strength, Quenched and Tempered Alloy Steel Plate, Suitable for Welding.
14. ASTM A529/A529M - Standard Specification for High-Strength Carbon-Manganese Steel of Structural Quality.
15. ASTM A563M - Standard Specification for Carbon and Alloy Steel Nuts (Metric).
16. ASTM A568/A568M - Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
17. ASTM A572/A572M - Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
18. ASTM A992 - Standard Specification for Steel for Structural Shapes.

C. American Welding Society:
1. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.
2. AWS D1.1 - Structural Welding Code - Steel.

D. Research Council on Structural Connections:
1. RCSC - Specification for Structural Joints Using ASTM A325 or A490 Bolts.

E. The Society for Protective Coatings (SSPC):
1. SSPC - Steel Structures Painting Manual.
2. SSPC Paint 15 - Steel Joist Shop Paint.
3. SSPC Paint 20 - Zinc-Rich Primers (Type I - Inorganic & Type II - Organic).

F. Underwriters Laboratories Inc.:
1. UL - Fire Resistance Directory.

1.3 SUBMITTALS

A. General Requirements: Requirements for submittals procedures.

B. Fabrication Drawings:
1. Indicate profiles, sizes, spacing, location of structural members, openings, attachments and fasteners.
2. Design and details of connections.
3. Cambers and loads.
4. Indicate welded connections with AWS A2.4 symbols and net weld lengths.

C. Mill Test Reports: Submit indicating structural strength, and destructive and nondestructive test analysis.

D. Manufacturer's Mill Certificate: Certify products meet the specified requirements.

E. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

1.4 QUALITY ASSURANCE (*Equivalent Equal Acceptable*)

A. Fabricate structural steel members in accordance with AISC S303.

B. Perform Work in accordance with AISC S303, Section 10.

A. Maintain one copy of each document on site.

D. Fabricator: Company specializing in performing Work of this section with minimum twenty years documented experience and holding current AISC Certification.

E. Erector: Company specializing in performing Work of this section with minimum ten years documented experience.

1.5 DELIVERY, STORAGE AND HANDLING

A. Store materials to permit easy access for inspection and identification. Support steel members off ground. Protect steel members and packaged materials from corrosion and deterioration. Materials showing evidence of damage will be rejected and shall be immediately removed from the site.

B. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replace damaged materials or structures as directed.

C. Do not handle structural steelwork until paint has thoroughly dried. Care shall be exercised to avoid abrasions and other damage.

D. All fasteners and washers shall be delivered to the site, where they will be installed, in unopened containers.

PART 2 PRODUCTS

2.1 MATERIALS (*Equivalent Equal Acceptable*)

A. Manufacturer: Any internationally recognized manufacturer having an official technical agreement to conformity with standards for the product.

B. Structural Steel Members: ASTM A36/A36M, ASTM A242/A242M, ASTM A514/A514M, ASTM A529/A529M, ASTM A568/A568M, and/or ASTM A572/A572M, Grade 40.

C. Structural Tubing: ASTM A500 and/or ASTM A501.

D. Pipe: ASTM A53/A53M, Grade B.

E. Shear Stud Connectors: ASTM A449. Forged steel, headed, and/or unfinished.

F. Suspension Cable: Wire rope.

G. Sag Rods: ASTM A36/A36M.

H. Bolts, Nuts, and Washers: ASTM A307, ASTM A325M bolts, ASTM A449 bolts, ASTM A490M bolts, ASTM A563 nuts, and/or galvanized to ASTM A123/A123M A153/A153M for galvanized structural members.

I. Anchor Bolts: ASTM A307 for embedded anchors; and high strength bolts for chemically and mechanically anchored anchors.

J. Welding Materials: AWS D1.1; type required for materials being welded.

K. Sliding Bearing Plates: Teflon coated.

L. Grout: Non-shrink type, pre-mixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing additives, capable of developing minimum compressive strength of 48 MPa at 28 days.

M. Shop and Touch-Up Primer: SSPC 15, Type 1, red oxide.

N. Touch-Up Primer for Galvanized Surfaces: SSPC 20, Type I: Inorganic, or Type II: Organic.

2.2 FABRICATION (*As Below Unless Agreed Otherwise With Owner*)

A. General:
1. Fabrication to be performed in accordance with Chapter M of AISC "Specification for Structural Steel Buildings" and the Drawings and Specifications.
   a. Assume all thermally cut edges are subject to substantial stresses.
   b. Paragraph M4.6 shall be considered deleted from Chapter M.
   c. The last sentence of paragraph M5.1 shall be deleted.
2. Provide holes and accessories required for securing other work to the work specified here.
3. Where thickness of material exceeds 7/8 inch or the diameter of hole, drill or ream holes after punching even when punching is allowed by referenced standards. Flame cut holes for fasteners are not acceptable.
4. Fabricate beams and girders with natural camber upward, unless otherwise shown or indicated on the Drawings.
5. Splice members only where indicated on Structural Drawings or where accepted by the Architect.
6. Remove burrs that would prevent solid seating of the connected parts.

B. Architecturally Exposed Steel:
1. All members exposed to view in the completed structure shall be classified as "Architecturally Exposed Structural Steel".
2. Comply with the provisions of the AISC Code of Standard Practice for Steel Buildings and Bridges regarding architecturally exposed structural steel.
   a. Abutting cross sectional configurations shall match.
   b. Remove backing bars.
   c. Remove weld runoff tabs and grind smooth
   d. All surfaces and welds exposed to view shall be treated as finished

surfaces.

3. Exposed Welds:
   a. All exposed fillet welds shall be made smooth of uniform convex contour, radius and dimension for their full length; grind smooth, if welds were not made to this criteria.
   b. All other exposed welds shall be milled or ground smooth and flush with the surfaces of the adjoining materials welded.
4. Weld show-through shall not be permitted.
5. Remove weld splatter on architecturally exposed steel.
6. All exposed corners shall be square and sharp, eased to a radius of 1/4 in.

C. Bolting, General:
1. Bolts shall be of a length that will extend not less than 1/4 in beyond the nuts unless noted otherwise.
2. Washers shall be used on Bolts. Use beveled washers where bolts bear on sloping surface.
3. Bolts shall be installed such that no threads occur in the shear plane.
4. Manufacturer's symbol and grade markings shall appear on all bolts and nuts.
5. Product containers must be marked so that correspondence with mill reports can be established.
6. Holes in column base-plates shall be no more than _ inch larger than the nominal bolt size.
7. Circular and slotted holes shall be as per Specification for Structural Joints Using ASTM A325 or A490 Bolts.
8. When bolt holes are subject to welding shrinkage stresses the holes shall be drilled.

D. Unfinished Bolts and Anchor Bolts:
1. Install and tighten unfinished bolts in accordance with requirements for snug tightened bolts as defined in "Specification for Structural Joints Using ASTM A325 or A490 Bolts".
2. Mutilate bolt threads for unfinished bolts to prevent the nuts from backing off.

E. High-Strength Bolts:
1. Install high-strength threaded fasteners in accordance with RCSC "Specifications for Structural Joints using ASTM A 325 or A 490 Bolts". Contact surfaces of bolted parts shall as a minimum comply with the class A requirements.
2. Unless otherwise noted, all connections are "slip critical (friction) type".
3. Tighten nuts using Direct Tension Indicator. Calibrated wrench and "Turn of Nut" methods are not acceptable.
4. When connection has bolts and welds, tighten bolts prior to welding with the exception that in moment connections the flange welds are completed prior to final tightening of high strength bolts.
5. When already tensioned bolts have had their tension relaxed, either re-torque the bolts using a calibrated wrench or replace the bolt and/or tension indicator and re-tighten.

F. Welding:
1. Welding shall be in accordance with AWS D1.1 "Structural Welding Code".
   a. Contractor is responsible for selection of specific materials and

procedures except as specifically noted in contract documents.

b. Connections have varying levels of restraint and thus necessary steps shall be taken by Contractor to control or accommodate the restraint.

c. Welding and fabrication procedures shall incorporate measures necessary to eliminate cracking. These measures shall include but are not limited to additional preheat, postheat, or retarded cooling.

d. When selecting materials and procedures, consideration shall be given to the need for materials and procedures in excess of code requirements.

e. The need for pre-heat and other procedures are to be based on the actual chemistry and mechanical properties and not solely on the grade for which the steel was certified.

f. Weld variables shall be consistent with the recommendations of the electrode manufacturer.

g. Welding Procedure Specifications shall be readily available to all welders, inspectors, and supervisors.

h. Welding procedures shall incorporate low hydrogen practices.

i. Use stringer beads only (no weaving).

2. No tack welds not incorporated into a weld will be allowed on the finished structure with the exception of backing plates that are not removed.

3. All groove or butt welds shall be full penetration unless noted otherwise on the Drawings.

4. Do not weld into column flange to column web intersection.

5. Sequence the Work as necessary to accommodate testing.

6. Remove-run-off tabs and backup plates and grind surfaces smooth as required for inspection or testing.

7. At “special moment connection” or “eccentrically braced frame” connections:

a. Remove backing bars and apply reinforcing fillet weld per note J of figure 2.4 of AWS D1.1.

b. Remove weld runoff tabs and grind smooth.

c. Delete “…root and …” from subsection 4.14.1.5 of AWS D1.1-94

d. Limit oscillation of FCAW electrodes to 3d, for d > = 3/32 inches, and to 5d, for d < 3/32 inch (d = wire diameter).

e. Pay increased attention to uniform and adequate preheat.

f. Maximum interpass temperature not to exceed 550 degrees F when notch toughness properties are specified.

g. Complete individual weld layers prior to applying portions of subsequent layers. Ends of interrupted passes to be staggered. Minimize starts and stops within body of the weld.

8. Splices of members in tension, that are made from ASTM A6 Group 4 of 5 rolled shapes, and or plates more than 2 inches thick shall be made in conformance with Section J1.7 of “Specification for Structural Steel Buildings ASD”, 9th Edition.

9. Shear Studs: Install shear studs in accordance with the manufacturer’s recommendations and AWS D1.1

10. Where tubes, pipes or other closed sections are exposed to the weather, provide seal welds where other specified welds do not provide a complete seal of the enclosed space.

G. Finishes of Architecturally Exposed Steel:

1. All surfaces of architecturally exposed structural steel members shall be

uniform in appearance, including smoothness and texture, when viewed in direct sunlight at a distance of 10 feet, at angles of incidence 0 degree to 90 degree at completion of the following stages of work:

a. "Surface Preparation" and "Shop Prime Painting".

2. Surface Appearance: The initial condition of steel to be exposed in use shall conform to SSPC-V is 1 Rust Grade A. The exposed surfaces, edges and ends of all plates and other components shall be free of any surface defects including weld splatter, burrs, dents, gouges, occlusions, streak, ridges and recesses. Such defects may be repaired and surface restored with weld or other approved filler material and machining (milling, grinding or sanding) to match appearance, including smoothness and texture, of parent surface.
3. All surfaces to be grit blasted to SA 2½ (Swedish Standards).

H. Shop Painting:

1. All structural steel exposed to the weather, classified as Architecturally Exposed Steel, or not completely concealed by interior finishes shall receive
   a shop coat of primer except as follows:
   a. Steel in contact with concrete.
   b. Contact surfaces of welded connections and areas within 4 in on each side of field welds.
   c. Machined surfaces.
   d. Contact surfaces of high-strength bolted connections.
   e. Reinforcing steel.
2. The following surfaces shall be temporarily protected by a thin coating of varnish or lacquer:
   a. Unpainted areas around field welds.
   b. Steel around high strength bolts.
   c. Machined surfaces.

2.3 FINISH (*As Below Unless Agreed Otherwise With Owner*)

A. Finish of Painted Steel Surfaces:

1. Prepare structural component surfaces in accordance with SSPC.
2. Grit blast surfaces to SA 2½ (Swedish Standards).
3. Shop prime structural steel members. Do not prime surfaces that will be fireproofed, field welded, in contact with concrete or high strength bolted.
4. Apply an approved three-coat protective paint system; provide minimum ten (10) year maintenance free guarantee for the paint system.

B. Finish of Galvanized Steel Surfaces:

1. Prepare structural component surfaces in accordance with SSPC.
2. Galvanize structural steel members to ASTM A123/A123M. Furnish minimum 380g/m² galvanized coating.
3. Apply an approved mordant coat prior to receiving the protective paint system.
4. Apply an approved three-coat protective paint system; provide minimum ten (10) year maintenance free guarantee for the paint system.

2.4 SOURCE QUALITY CONTROL AND TESTS (*As Below Unless Agreed Otherwise With Owner*)

A. Testing and inspection of structural steelwork will be performed by the independent testing agency cost of which shall be borne by Contractor. Provide the Inspector with the following.
   1. A complete set of accepted "Submittals"
   2. Cutting lists, order sheets, material bills, and shipping bills
   3. Representative sample pieces as requested by the testing agency
   4. full and ample means and assistance for testing all material
   5. Access and facilities, including scaffolding, temporary work platforms, etc., for testing and inspection at all places where materials or components are stored or fabricated, and also in their erected position.

B. Scheduling of Tests and Inspections
   1. The Contractor shall notify the Inspector in sufficient time prior to fabrication or erection work to allow testing and inspection without delaying the work.
   2. Shop welds will be inspected in the shop before the work is painted or shipped.

C. Each person installing connections shall be assigned an identifying symbol or mark and all shop and field connections shall be so identified so that the Inspector can refer back to the person making the connection.

D. Non-destructive Testing and Inspections
   1. As a minimum the inspector shall make all tests and inspections as required by the 1997 Uniform Building Code Inspector will make all the tests and inspections indicated in the Construction Documents.
   2. The Inspector shall make all verification tests and inspections as required by AWS D1.1 "Structural Welding Code".
   3. Do not reduce testing frequency unless permission is obtained from the Engineer.
   4. Inspector shall be present during all welding operations.
   5. Verify that welders are certified.
   6. Check materials, equipment and procedures. Verify meters on welding equipment are functioning and are accurate.
   7. Visual Inspection:
      a. Visually inspect all welds.
      b. Visual inspection of multi-pass welds to be continuous.
      c. Visually inspect welds to Group 4 and 5 sections of at least 72 hours after completion of welding for the presence of cracks.
   8. Test Methods:
      a. Butt welds will be tested using ultrasonic or radiographic test methods.
      b. Butt welds to pipes and tubes to be tested using magnetic particle tests.
      c. Use magnetic partial test methods for filet welds and the supplement the testing requirements for butt welds.
      d. At inspector's option dye penetrant testing, and resistance testing methods may be used in place of or to supplement magnetic particle testing.
      e. For radiographic a double film technique will be used. One copy of

each film will be sent to the Architect, the other will be retained by the Inspector.

f. In addition to the non-destructive testing specified other nondestructive test methods recognized by AWS D1.1 may be used at the Architects discretion and the results can be used to reject work under this contract.

9. Frequency of non-destructive examination is to be as follows:
   a. Full penetration butt welds: 100 percent.
   b. Partial penetration butt welds with a leg length greater than 1/2 in: 20 percent min. ultrasonic or radiographic inspection.
   c. Test 100 % of partial penetration butt welds used in column splices.
   d. Test 20 % of total length of all welds joining web plates to flanges.
   e. Fillet and other welds not otherwise addressed - a minimum of 10 %.
   f. Selection of welds to be examined: Where there is a requirement for less than 100% examination the method of selection of welds to be examined is to be agreed with the Engineer before commencement of the work. If the Engineer does not provide more specific criteria inspectors will select the welds to be tested. The inspectors will chose specific weld so as to obtain results that are representative of the conditions in the structure. In addition inspectors will emphasize those locations that experience has shown are more likely to have problems.
   g. On five percent of the full penetration butt welds as chosen by the inspector/engineer, after removing, run-off tabs, grind the end of the weld sufficiently to allow determination of number and sizes of weld passes.

10. Testing of Base Metal: These provisions are in addition to other applicable requirements.
   a. The edges of material to be welded will be ultrasonically examined for evidence of laminations, inclusions or other discontinuities.
   b. Ultrasonically test column flanges and webs at the location of all moment connections and brace connections. Test for a distance 3 inches around the location to be welded. The test procedure and acceptance criteria is defined by ASTM A898-91, “Standard Specification for Straight Beam Ultrasonic Examination of Rolled Steel Structural Shapes” Level I.
   c. Base metal thicker than 1½ inches, when subjected to throughthickness weld shrinkage strains, shall be ultrasonically inspected for discontinuities behind and within a distance of 3 inches of such welds after joint completion. Any material discontinuities shall be accepted or rejected on the basis of the defect rating in accordance with flaw severity, Class B criteria in Table 8.2 in AWS D1.1.

11. Where inspection reveals unacceptable defects:
   a. The extent of inspection will be increased as much as necessary to assure that the full extent of the defects in a joint has been found and to assure that the same defects are not present elsewhere.
   b. As minimum, examine two additional joints in the group represented by the joint. If the non-destructive examination of the two additional joints reveals unacceptable defects, examine each joint in the group.

E. Take samples of all welding consumables and store in sealed containers.

F. Tests of high strength bolts, nuts and washers:

1. The Inspector will make all tests and inspections of high strength bolt connections as required by RCSC "Specifications for Structural Joints Using ASTM A 325 or A 490 Bolts".
2. Observe all Direct Tension Indicators to see if proper tightness was achieved.
3. Confirm that the faying surfaces have been properly prepared before connections are assembled.

G. Testing of End-Welded Studs:

1. End-welded studs shall be random sampled and tested from stock furnished to each project. Tests shall meet the requirements in Table 7.1 of AWS D1.1. The minimum number of tests of each required property shall be as follows:

Number of Pieces to Be Used from Identified Package	**Number of Specimens**
150 and less	1
151 to 280	2
281 to 500	3
501 to 1200	5
1201 to 3200	8
3201 to 10000	13
10001 and over	20

A minimum of three pieces from each lot shall be tested.

2. Production control testing shall be in accordance with AWS D1.1 Chapter 7.
3. As a minimum test, in accordance with AWS D1.1 paragraph 7.8, ten percent of all welded studs.

H. Inspection Records

1. Make systematic record of all welds, including:
   a. Location and type of weld.
   b. Identification marks of welders.
   c. List of defective welds.
   d. Manner of correction of defects.
2. The Inspector will maintain a daily record of the work that has been inspected and its disposition. One copy of each of the report will be submitted to the Owner on a weekly basis. Test reports will be made on the form suggested in the AWS D1.1 "Structural Welding Code".

PART 3 EXECUTION

3.1 EXAMINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

3.2 ERECTION

A. Allow for erection loads, and for sufficient temporary bracing to maintain structure safe, plumb, and in alignment until completion of erection and installation of

permanent bracing.

B. Field weld components and shear studs as indicated on fabrication drawings.

C. Field connect members with threaded fasteners; torque to required resistance tighten to snug tight for bearing type connections.

D. Do not field cut or alter structural members without approval of the Engineer.

E. After erection, prime welds, abrasions and surfaces not shop primed or galvanized, except surfaces to be in contact with concrete.

F. Grout under base plates in accordance with Section 04065. Trowel grouted surface smooth, splay neatly to 45 degrees.

3.3 ERECTION TOLERANCES

A. General Requirements: Quality requirements for tolerances.

B. Maximum Variation from Plumb: 6 mm per story, non-cumulative.

C. Maximum Offset from Alignment: 6 mm.

3.4 FIELD QUALITY CONTROL

A. General Requirements: Quality requirements for testing and inspection services, and execution requirements for testing, adjusting and balancing.

3.5 SCHEDULES

A. As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 05500

METAL FABRICATIONS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes shop fabricated metal items.

B. Related Sections:
1. Section 03300 - Cast-In-Place Concrete.
2. Section 04810 - Unit Masonry Assemblies.
3. Section 05510 - Metal Stairs and Ladders.
4. Section 05520 - Handrails and Railings.
5. Section 07140 - Fluid Applied Waterproofing.
6. Section 07212 - Board Insulation.
7. Section 07260 - Vapor Retarders.
8. Section 07270 - Air Barriers.
9. Section 07900 - Joint Sealers.
10. Section 09900 - Paints and Coatings.
11. Division 15 - Mechanical: Diffusers, registers and grilles.

1.2 REFERENCES

A. Aluminum Association:
1. AA DAF-45 - Designation System for Aluminum Finishes.

B. American Architectural Manufacturers Association:
1. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.
2. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.
3. AAMA 2604 - Voluntary specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.
4. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.

C. ASTM International:
1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
2. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
3. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
4. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
5. ASTM A167 - Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
6. ASTM A276 - Standard Specification for Stainless Steel Bars and Shapes.

7. ASTM A297/A297M - Standard Specification for Steel Castings, Iron-Chromium and Iron-Chromium-Nickel, Heat Resistant, for General Application.
8. ASTM A283/283M - Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
9. ASTM A307 - Standard Specification for Carbon Steel Bolts and Studs, 60000 PSI Tensile Strength.
10. ASTM A312/A312M - Standard Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
11. ASTM A325M - Standard Specification for High-Strength Bolts for Structural Steel Joints (Metric).
12. ASTM A354 - Standard Specification for Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners.
13. ASTM A500 - Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
14. ASTM A501 - Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
15. ASTM A554 - Standard Specification for Welded Stainless Steel Mechanical Tubing.
16. ASTM B26/B26M - Standard Specification for Aluminum-Alloy Sand Castings.
17. ASTM B85 - Standard Specification for Aluminum-Alloy Die Castings.
18. ASTM B177 - Standard Guide for Chromium Electroplating on Steel for Engineering Use.
19. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
20. ASTM B210M - Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes (Metric).
21. ASTM B211M - Standard Specification for Aluminum and Aluminum-Alloy Bar, Rod, and Wire (Metric).
22. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).

D. American Welding Society:
1. AWS A2.4 - Standard Symbols for Welding, Brazing, and Nondestructive Examination.
2. AWS D1.1 - Structural Welding Code - Steel.
3. AWS D1.6 - Structural Welding Code - Stainless Steel.

E. National Ornamental & Miscellaneous Metals Association:
1. NOMMA Guideline 1 - Joint Finishes.

F. The Society for Protective Coatings (SSPC):
1. SSPC - Steel Structures Painting Manual.
2. SSPC SP 1 - Solvent Cleaning.
3. SSPC SP 2 - Hand Tool Cleaning.
4. SSPC SP 10 - Near-White Blast Cleaning.
5. SSPC Paint 15 - Steel Joist Shop Paint.
6. SSPC Paint 20 - Zinc-Rich Primers (Type I - Inorganic & Type II - Organic).

1.3 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

B. Shop Drawings: Indicate profiles, sizes, connection attachments, reinforcing, anchorage, size and type of fasteners, and accessories. Include erection drawings, elevations, and details where applicable. Indicate welded connections using standard AWS A2.0 welding symbols. Indicate net weld lengths.

C. Shop Drawings for Slab edge Panels: Indicate dimensions, panel profile and layout, spans, joints, expansion joints, construction details, methods of anchorage, method and sequence of installation and interface with adjacent materials.

D. Samples: Submit two samples of each metalwork type, size as directed by the Engineer, illustrating factory finishes.

E. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

F. Design and Performance Data: Submit panel profile characteristics and dimensions, and structural properties. Submit design calculations.

G. Manufacturer's Installation Instructions: Submit special handling criteria, installation sequence, and cleaning procedures.

1.4 QUALITY ASSURANCE

A. Materials and work shall conform to the latest edition of reference specified herein and to applicable codes and requirements of local authorities having jurisdiction, including the following:
   1. The National Association of Architectural Metal Manufacturers (NAAMM)
      a. Metal Finishes Manual
      b. Metal Bar Grating Manual
      c. Metal Products Outline Manual

B. Qualify welding processes and welding operators in accordance with AWS D1.1 “Structural Welding Code – Steel,” D1.3 “Structural Welding Code – Sheet Steel”, and D1.2 “Structural Welding Code – Aluminum”.

C. Structural Performance: Design, engineer, fabricate and install metal fabrications to withstand structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections. Comply with the “Performance Criteria” specified hereinafter.

D. Conflicting Requirements: In the event of conflict between pertinent codes and regulations and the requirements of the referenced standards or these specifications, the provisions of the more stringent shall govern.

E. Design cold-formed framing to comply with ASCE-7-95 and Uniform Building Code.
   1. Design Load for Exterior Wall assembly: Not less than 146 kg/m².
   2. Increase size of individual members, including anchorage, or reinforce to

resist loads without undue deflection.

F. Maximum Horizontal Deflection at Mid-Plan
   1. At Ceramic Tile: 10mm or L/600 of span based on moment of inertia of stud cross section only, whichever is less.
   2. Increase size of individual members, including anchorage, or reinforce to resist loads without undue deflection.

G. Sloped Sills: Size to resist wind loads plus anticipated live loads of 195 kg/m², but not less than 1.5mm thick.

H. Interior Locations Indicated as Structural Steel Stud: Size to resist anticipated loads, but not less than 0.9mm thick unless otherwise indicated.

I. Differential Movement: Design and construct wall system to accommodate anticipated movement indicated herein, without damage or deterioration to studs or wallboards, without buckling, opening of joints, and cracking.

J. Certifications: Work of this Section shall be performed under the direct supervision of a registered Professional Engineer.

K. Perform Work in accordance with the drawings and to the approval of the Engineer.

L. Maintain one copy of each document on site.

1.5 QUALIFICATIONS

A. Design under direct supervision of Professional Engineer experienced in design of this Work and approved by the Engineer.

B. Manufacturer: Company specializing in manufacturing products specified in this section with minimum ten years documented experience.

C. Installer: Company specializing in performing Work of this section with minimum five years documented experience.

1.6 DELIVERY, STORAGE AND HANDLING

A. General Requirements: Product requirements for product storage and handling.

B. Accept metal fabrications on site in labeled shipments. Inspect for damage.

C. Protect metal fabrications from damage by exposure to weather.

1.7 FIELD MEASUREMENTS

A. Verify field measurements are as indicated on shop drawings, and/or as instructed by the manufacturer.

PART 2 PRODUCTS

2.1 MATERIALS - STEEL

A. Steel Sections: ASTM A36/A36M.

B. Steel Tubing: ASTM A500, Grade B, and/or ASTM A501.

C. Plates: ASTM A283/A283M.

D. Pipe: ASTM A53/A53M, Grade B, Schedule 40.

E. Fasteners: as instructed by the manufacturer.

F. Bolts, Nuts, and Washers: ASTM A325M, A307 and/or galvanized to ASTM A153/A153M for galvanized components.

G. Welding Materials: AWS D1.1; type required for materials being welded.

H. Shop and Touch-Up Primer: SSPC Paint 15, Type 1, red oxide.

I. Touch-Up Primer for Galvanized Surfaces: SSPC Paint 20 Type I Inorganic and/or Type II Organic zinc rich.

2.2 MATERIALS - STAINLESS STEEL

A. Bars and Shapes: ASTM A276, and/or ASTM A479/A479M; Type 316.

B. Tubing: ASTM A269, and/or ASTM A554; Type 316.

C. Pipe: ASTM A312/A312M, seamless and/or welded; Type 316.

B. Plate, Sheet and Strip: ASTM A167; Type 316.

E. Bolts, Nuts, and Washers: ASTM A354.

F. Welding Materials: AWS D1.6; type required for materials being welded.

2.3 MATERIALS - ALUMINUM

A. Extruded Aluminum: ASTM B221M, Alloy 6063, Temper T5.

B. Sheet Aluminum: ASTM B209M.

C. Aluminum-Alloy Drawn Seamless Tubes: ASTM B210M, Alloy 6063, Temper T6.

D. Aluminum-Alloy Bars: ASTM B211M, Alloy 6063, Temper T6.

E. Aluminum-Alloy Sand Castings: ASTM B26/B26M.

F. Aluminum-Alloy Die Castings: ASTM B85.

G. Bolts, Nuts, and Washers: Stainless steel type 316.

H. Welding Materials: AWS D1.1; type required for materials being welded.

2.4 ISOLATING NON-CONDUCTIVE MATERIALS BETWEEN DISSIMILAR METALS

A. Contacts between dissimilar metals should be avoided in order to prevent bi-metallic or galvanic corrosion.

B. Dissimilar metals shall be isolated from each other with non-conductive materials. Generally, such isolating elements will take the form of washers and bushes.

C. Isolated Non-Conductive Materials: Neoprene, synthetic resin bonded fiber (SRBF) such as tufnol, polytetrafluoroethylene (PTFE), or hard nylon, depending on the fixing:
   1. Load Bearing Fixings: SRBF or PTFE (strong material).
   2. Restraint Fixings: Neoprene or nylon is acceptable.

D. Electrical insulation tape and bitumen paint are considered in low risk short life application, and shall not be used as non-conductive materials unless directed by the Engineer.

2.5 LINTELS

A. Lintels: Steel sections, size and configuration as indicated on Drawings, length to allow 200 mm minimum bearing on both sides of opening.
   1. Exterior Locations: Galvanized, and/or prime paint, one coat.
   2. Interior Locations: Prime paint, one coat.

2.6 LEDGE AND SHELF ANGLES

A. Ledge and Shelf Angles, Channels and/or Plates Not Attached to Structural Framing: For support of metal decking, joists, and/or masonry; galvanized and/or prime paint, one coat.

2.7 ELEVATOR SILL ANGLES AND HOIST AND DIVIDER BEAMS

A. Sill Angles: Steel sections as indicated on Drawings for support of elevator sills; galvanized and/or prime paint, one coat.

B. Hoist and Divider Beams: Steel wide flange sections, shape and size required to support applied loads with maximum deflection of 1/240 of the span; prime paint, one coat.

2.8 DOOR FRAMES

A. Door Frames: Steel channel and/or angle sections, size as indicated on Drawings, with jamb anchors suitable for building into masonry and/or attachment to concrete, or steel framing, minimum 4 anchors per jamb; galvanized or prime paint, one coat.

2.9 LADDERS

A. Steel, Aluminum and/or Stainless Steel Ladder: ANSI A14.3, steel, aluminum and/or stainless steel welded construction: Unless otherwise indicated on drawings,
   1. Side Rails: 9 x 50 mm side rails spaced at 500 mm.
   2. Rungs: 25 mm diameter solid and/or tubular rod spaced 300 mm on center.
   3. Mounting: Space rungs 175 mm from wall surface; with steel mounting brackets and attachments.
   4. Finish: Galvanized, enamel, anodized, satin chrome, or polished chrome finish, as selected.

B. Ladder Safety Cage: Unless otherwise indicated on drawings, Steel and/or Aluminum bar sections, minimum 6 x 50 mm.
   1. Bottom hoop 455 mm radius maximum 1880 mm above finished floor.
   2. Other hoops 355 mm radius spaced maximum 1220 mm on center.
   3. Vertical bars spaced 250 mm on center.
   4. Finish: Match ladder finish.

C. Ladder Security Enclosure: Unless otherwise indicated on drawings, Sheet steel minimum 1.5 mm thick, formed to enclose ladder side rails and rungs when closed and to swing free of ladder rungs and side rails with minimum 38 mm clear to side rails in open position.
   1. Provide continuous steel hinge full height of enclosure.
   2. Provide steel hasp for padlocking in closed and open position.
   3. Finish: Match ladder finish.

2.10 STRUCTURAL SUPPORTS

A. Structural Supports for Miscellaneous Attachments: Steel sections, shape and size as indicated on Drawings, required to support applied loads (Dead & Live) with maximum deflection of 1/200 of the span; prime paint, one coat or mill finish.

2.11 ALUMINUM VENTILATION GRILL LOUVERS

A. Coordinate Work with Division 15 - Mechanical and in particular Diffusers, Registers, and Grilles.

2.12 ANCHOR BOLTS

A. Anchor Bolts: ASTM A307; steel bolt, standard J-hook, with nut and washer; unfinished.

2.13 FOOT SCRAPERS

A. Foot Scrapers: As detailed; aluminum, mill finish and/or steel galvanized, or prime paint, one coat.

2.14 FABRICATION

A. Fit and shop assemble items in largest practical sections, for delivery to site.

B. Fabricate items with joints tightly fitted and secured.

C. Continuously seal joined members by intermittent welds and plastic filler and/or continuous welds.

D. Exposed Welded Joints: NOMMA Guideline 1 Joint Finish.

E. Exposed Mechanical Fastenings: Flush countersunk screws or bolts; unobtrusively located; consistent with component design, except where specially noted otherwise.

F. Supply components required for anchorage of fabrications. Fabricate anchors and related components of same material and finish as fabrication, except where specifically noted otherwise.

2.15 FACTORY APPLIED FINISHES - STEEL

A. Prepare surfaces to be primed in accordance with SSPC SP 2.

B. Clean surfaces of rust, scale, grease, and foreign matter prior to finishing.

C. Do not prime surfaces in contact with concrete or where field welding is required.

D. Prime paint items with one or two coats except where galvanizing is specified.

E. Galvanized Structural Steel Members: Galvanize after fabrication to ASTM A123. Furnish minimum 380 g/sq m galvanized coating.

F. Galvanized Non-structural Items: Galvanized after fabrication to ASTM A123. Furnish minimum 380 and/or 360 g/m² galvanized coating.

G. Chrome Plating: ASTM B177, nickel-chromium alloy, satin and/or polished finish.

2.16 FACTORY APPLIED FINISHES - STAINLESS STEEL

A. Satin Polished Finish: Number 4, satin directional polish parallel with long dimension of finished face. Color: As selected.

B. Mirror Polished Finish: Number 8, mirror polish with preliminary directional polish lines removed. Color: As selected.

2.17 FACTORY APPLIED FINISHES - ALUMINUM

A. Finish coatings to conform to AAMA 2603, 2604, 2605 and/or AAMA 611. Comply with AA DAF-45.

B. Exterior and Interior Aluminum Surfaces: Advanced Durability Polyester Powder Coating System. Color: As selected. Minimum cover thickness 60 microns. Gloss Percentage: As selected.

C. Apply one coat of bituminous paint to concealed aluminum surfaces in contact with cementitious or dissimilar materials.

2.18 FABRICATION TOLERANCES

A. Squareness: 3 mm maximum difference in diagonal measurements.

B. Maximum Offset between Faces: 1.5 mm.

C. Maximum Misalignment of Adjacent Members: 1.5 mm.

D. Maximum Bow: 3 mm in 1.2 m.

E. Maximum Deviation from Plane: 1.5 mm in 1.2 m.

PART 3 EXECUTION

3.1 EXAMINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Verify field conditions are acceptable and are ready to receive Work.

3.2 PREPARATION

A. Clean and strip primed steel items to bare metal and aluminum where site welding is required.

B. Supply steel items required to be cast into concrete, or embedded in masonry with setting templates to appropriate sections.

3.3 INSTALLATION

A. Install work of this section square, plumb, straight, true to line or radius, accurately fitted and located, with flush tight hairline joints (except as indicated otherwise or to allow for thermal movement). Provide attachment devices as required for secure and rigid installation.

B. Exposed joints shall be close fitting, and bolts and screws, where exposed, shall be cut off flush with nuts or other adjacent metal. Cutting, drilling, punching and tapping required for the installation and attachment of other work to miscellaneous metal work, except where specified in connection with work under other sections, shall be performed as required.

C. Metal work built-in with concrete or masonry shall be formed for anchorage, or be provided with suitable anchors, expansion shields or other anchoring devices shown on the drawings, or required. Such metal work shall be furnished in ample time for setting and securing in place. Wherever possible fixings shall be built into concrete.

D. Where indicated, install miscellaneous metal items in sleeves (furnished under this section) embedded in concrete with setting grout specified herein.

E. Joints shall be as strong and rigid as adjoining sections. Welding shall be continuous along entire line of contact, except where spot welding is indicated or permitted. Where exposed, welds shall be ground smooth. Where bolted or riveted connections are indicated, such connections may be welded at the Contractor's option.

F. Where welding is required, it shall conform to requirements for shielded metal arc welding of the Standard Code for Arc and Gas Welding of the American Welding Society. Exposed welds shall be flush and ground smooth.

G. Threaded connections shall be made up tight so that threads are entirely concealed. Abutting bars shall be so shouldered and headed, doweled and pinned. Small bars shall pass through larger bars and pinned. Rivet, bolts and screw heads shall be flat and countersunk in exposed work and elsewhere as required. Removable members shall be carefully machined and fitted and secured, by means of screws or bolts of proper size and approved spacing.

H. Bolts, brackets, sleeves and other items embedded in concrete shall be galvanized.

I. Except where built in fixings cannot be used miscellaneous metal work may be fastened to concrete with expansion bolts and to hollow with toggle bolts. Fastening to wood plugs in concrete or masonry will not be permitted. Holes for plugs or bolts shall be drilled to the exact diameter of the plug or bolt, using a percussion drill for concrete and a rotary drill for masonry. Screws shall be threaded full length to the head of the screw.

J. Provide for adjustments of miscellaneous metal items, with particular attention given to miscellaneous steel supporting the work of other sections, as required during the construction process.

K. Install isolating non-conductive materials between dissimilar metals as per approved methodology.

L. Setting Loose Plates:
   1. Clean concrete and masonry bearing surfaces of any bond-reducing materials, roughen to improve bond to surfaces. Clean bottom surface of bearing plates.
   2. Set loose leveling and bearing plates on wedges, or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut off flush with the edge of the bearing plate before packing with grout.
   3. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

M. Butt welds or splice butt joints in track. Splices in axial loaded studs shall not be permitted. Welds shall be fillet, plug, butt, or seam.
   1. Secure floor and ceiling runners to structure with power driven anchors spaced not over 400mm on center and 150mm maximum from ends. Closer spacing at discretion of stud manufacturer based on design loads.
   2. Provide elastomeric sealant or sill sealer material between concrete structure and ceiling and floor runner channels at exterior.

N. Slide Clip Detail: Provide flexible connection between studs and building structure to

accommodate slab edge deflection and long term building creep without transferring axial load to studs.

O. Tolerance: Wall construction to a maximum variation from plumb, level, or true-toline of 3mm in 3m.

P. Obtain approval of the Engineer prior to site cutting or making adjustments not scheduled.

Q. After erection, touch up welds, abrasions, and damaged finishes with prime paint or galvanizing repair paint to match shop finishes.

3.4 ERECTION TOLERANCES

A. General Requirements: Quality requirements for tolerances.

B. Maximum Variation from Plumb: 6 mm per story or for every 3.65 m in height whichever is greater, non-cumulative.

C. Maximum Offset from Alignment: 6 mm.

D. Maximum Out-of-Position: 6 mm.

3.5 CLEANING

A. General Requirements: Execution requirements for final cleaning.

B. Remove site cuttings from finish surfaces.

C. Clean and wash prefinished surfaces with mild soap and water; rinse with clean water.

3.6 SCHEDULES

A. As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 06200

FINISH CARPENTRY

PART 1 GENERAL

1.1 SUMMARY

A. Section includes finish carpentry items; wood door frames, glazed frames; wood casings and moldings; and hardware and attachment accessories.

B. Related Sections:
1. Section 06410 - Custom Cabinets: Shop fabricated custom cabinet work.
2. Section 08212 - Flush Wood Doors.
3. Section 08800 - Glazing.
4. Section 09900 - Paints and Coatings: Finishing of finish carpentry items.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI A135.4 - Basic Hardboard.
2. ANSI A156.9 - Cabinet Hardware.
3. ANSI A208.1 - Mat-Formed Wood Particleboard.

B. APA-The Engineered Wood Association:
1. APA/EWA PS 1 - Voluntary Product Standard for Construction and Industrial Plywood.

C. ASTM International:
1. ASTM C1036 - Standard Specification for Flat Glass.
2. ASTM C1048 - Standard Specification for Heat-Treated Flat Glass-Kind HS, Kind FT Coated and Uncoated Glass.
3. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

D. Architectural Woodwork Institute:
1. AWI - Quality Standards Illustrated.

E. American Wood-Preservers' Association:
1. AWPA C1 - All Timber Products - Preservative Treatment by Pressure Process.

F. Federal Specification Unit:
1. FS A-A-1936 - Adhesive, Contact, Neoprene Rubber.

G. Hardwood Plywood and Veneer Association:
1. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood.

H. National Institute of Standards and Technology:
1. NIST PS 20 - American Softwood Lumber Standard.

I. National Electrical Manufacturers Association:
   1. NEMA LD 3 - High Pressure Decorative Laminates.

J. Window and Door Manufacturers Association:
   1. WDMA I.S.4 - Water-Repellent Treatment for Millwork.

K. Woodwork Institute of California:
   1. WIC - Manual of Millwork.

1.3 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

B. Shop Drawings: Indicate materials, component profiles, fastening methods, jointing details, and accessories to minimum scale of (1:8).

C. Product Data:
   1. Submit data on fire retardant treatment materials and application instructions.
   2. Submit data on attachment hardware and/or finish hardware.

D. Samples:
   1. Submit two samples of finish plywood, 200 x 250 mm in size illustrating wood grain and specified finish.
   2. Submit two samples of wood trim 250 mm long.
   3. Submit two samples of laminates, pre-finished paneling, synthetic surfacing, hardware items, and/or shop finishes.

E. Certification: Submit copy of fabricator's authorization to use AWI Grade Stamps, AWI Quality Certification Program license and Project specific letters and/or WIC certified compliance certificate.

1.4 QUALITY ASSURANCE

A. Perform work in accordance with AWI (Architectural Woodwork Institute) Architectural Woodwork Quality Standards Illustrated, or WIC (Woodwork Institute of California) Manual of Millwork; economy, custom or premium grade.

B. Maintain one copy of each document on site.

1.5 QUALIFICATIONS

A. Fabricator: Company specializing in fabricating Products specified in this section with minimum ten years documented experience.

1.6 MOCKUP

A. General Requirements: Quality requirements for mockup.

B. Construct mockups, full size including all hardware and attachment accessories.

C. Locate where directed by the Engineer.

D. Remove mockup when directed by the Engineer.

1.7 PRE-INSTALLATION MEETINGS

A. General Requirements: Administrative requirements for pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE AND HANDLING

A. General Requirements: Product requirements for product storage and handling.

B. Protect work from moisture damage.

1.9 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

1.10 SEQUENCING

A. Sequence work to ensure utility connections are achieved in orderly and expeditious manner.

1.11 COORDINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Coordinate work with plumbing rough-in, electrical rough-in, and installation of associated and adjacent components.

PART 2 PRODUCTS

2.1 FINISH CARPENTRY

A. Manufacturer: Any internationally recognized manufacturer having an official technical agreement to conformity with standards for the product.

2.2 COMPONENTS

A. Softwood and/or Hardwood Lumber: NIST PS 20, or AWI grade III, II or I, WIC economy, custom or premium grade; maximum moisture content of 6 to 8 %.

B. Softwood and/or Hardwood Plywood: APA/EWA PS 1 Grade (C-D) softwood plywood, HPVA HP-1 hardwood plywood, AWI grade B, A, or AA veneer; and/or WIC economy, custom or premium veneer; with particleboard, medium density fiberboard, veneer or lumber core; type of glue recommended for application.

C. High Pressure Decorative Laminate: NEMA LD 3, GP50 for horizontal surfaces, GP28 for vertical surfaces, CL20 for cabinet liner surfaces, BK20 for undecorated backing sheets, PF42 for post forming, FR50 for fire-retardant surfaces; color, pattern, and surface texture as selected and indicated.

D. Pre-finished Paneling: As indicated on drawings.

E. Wood Particleboard: ANSI A208.1 type 1 or 2; composed of wood chips or sawdust, medium density, made with water resistant adhesive; sanded faces.

F. Hardboard: AHA A135.4; Pressed wood fiber with resin binder, standard and/or tempered grade, 6 mm thick, smooth one and/or two sides.

G. Pegboard: Pressed wood fiber with resin binder, standard and/or tempered grade; 3 mm thick 4 mm diameter holes at 25 mm on center and/or 6 mm thick with 7 mm diameter holes at 25 mm on center.

H. Sheet Metal Components: Stainless steel, Type 316 with #4 satin and/or #8 polished finish.

I. Synthetic Surfacing: Synthetic marble of polyester or proprietary resins, with color and design as indicated on drawings, stain resistant to domestic chemicals and cleaners.

2.3 ACCESSORIES

A. Adhesive for High Pressure Decorative Laminates: FS A-A-1936 contact adhesive and/or Type recommended by laminate manufacturer to suit application.

B. Fasteners: Of size and type to suit application; galvanized finish in concealed locations and stainless steel type 316 finish in exposed locations.

C. Concealed Joint Fasteners: Threaded steel.

D. Lumber for Shimming and Blocking: Softwood lumber as indicated.

E. Veneer Edge Band: Standard wood veneer edge band matching face veneer.

F. Plastic Edge Trim: Extruded convex and/or flat shaped; smooth and/or ridged finish; self locking serrated tongue; of width to match component thickness; color as selected.

G. Aluminum Edge Trim: Extruded convex and/or flat shape; smooth and/or ridged surface finish; self locking serrated tongue; of width to match component thickness; natural mill, clear anodized and/or bronze anodized finish.

H. Glass: Type as specified in Section 08800.

I. Float and/or Patterned Glass: ASTM C1036 and/or C1048, type, color, pattern, quality and thickness as indicated on drawings.

J. Safety Glass: ASTM C1036 and/or C1048, type, color, pattern, quality and thickness as indicated on drawings.

K. Primer: Alkyd primer sealer.

L. Wood Filler: Solvent and/or oil base, tinted to match surface finish color.

M. Wood Treatment:
1. Fire Retardant (FR-S Type): Chemically treated and pressure impregnated; capable of providing maximum flame spread/smoke development rating in accordance with ASTM E84.
2. Wood Preservative by Pressure Treatment (PT Type): AWPA Treatment C1 using water borne preservative with 0.25 lb/cu ft retention.
3. Water Repellant Preservative Treatment by Dipping Method: WDMA I.S.4, with 0.25 cubic lb/in/ft of chromated copper arsenate.
4. Wood Preservative (Surface Application): color and type as indicated.
5. Shop pressure treat, dip and/or brush apply treatment to wood materials requiring fire rating and/or preservatives to concealed wood blocking.
6. Provide identification on fire retardant treated material.
7. Deliver fire retardant treated materials cut to required sizes. Minimize field cutting.
8. Redry and/or Kiln dry wood after pressure treatment to maximum moisture content percentage as instructed by the manufacturer.

N. Hinges: As indicated on drawings.

O. Pulls: As indicated on drawings.

P. Latches: As indicated on drawings.

Q. Shelf Standards: As indicated on drawings.

R. Shelf Brackets: As indicated on drawings.

S. Drawer Slides: As indicated on drawings.

2.4 FABRICATION

A. Fabricate to AWI Economy, Custom and/or Premium standards and/or WIC Economy, Custom and/or Premium standards.

B. Shop assemble work for delivery to site, permitting passage through building openings.

C. Fit exposed sheet material edges with matching hardwood, matching veneer, plastic and/or aluminum edging. Use one piece for full length only.

D. Cap exposed high pressure decorative laminate finish edges with material of same finish and pattern.

E. Shop prepare and identify components for book match grain matching during site erection.

F. When necessary to cut and fit on site, fabricate materials with ample allowance for

cutting. Furnish trim for scribing and site cutting.

G. Apply high pressure decorative laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Locate counter butt joints minimum 600 mm from sink cut-outs.

H. Apply laminate backing sheet to reverse face of high pressure decorative laminate finished surfaces.

2.5 SHOP FINISHING

A. Sand work smooth and set exposed nails and screws.

B. Apply wood filler in exposed nail and screw indentations.

C. On items to receive transparent finishes, use wood filler matching surrounding surfaces and of types recommended for applied finishes.

D. Finish work in accordance with AWI - Section 1500 Finish System Transparent and/or Opaque.

E. Finish work in accordance with WIC - Section 25 System (#1) (#2) (#3) (#4) (#5) (#6) (#7) (#8).

F. Stain, seal, and varnish exposed to view surfaces.

G. Seal internal surfaces and semi-concealed surfaces.

H. Prime paint and/or Seal surfaces in contact with cementitious materials.

PART 3 EXECUTION

3.1 EXAMINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Verify adequacy of backing and support framing.

C. Verify mechanical, electrical, and building items affecting work of this section are placed and ready to receive this work.

3.2 EXISTING WORK

A. Modify and extend existing finish carpentry installations using materials and methods as specified.

3.3 INSTALLATION

A. Install work in accordance with AWI, or WIC economy, custom or premium quality

standard.

B. Set and secure materials and components in place, plumb and level.

C. Carefully scribe work abutting other components, with maximum gaps of 1 mm. Do not use additional overlay trim to conceal larger gaps.

D. Install components and/or trim with nails, screws and/or bolts with blind fasteners as instructed by the manufacturer, and/or wall adhesive by gun application.

E. Install pre-finished paneling with full bed contact adhesive applied to substrate, and/or nails, screws and/or wall adhesive by bead method as instructed by the manufacturer.

F. Install hardware.

G. Site Applied Wood Treatment:
   1. Apply preservative treatment.
   2. Brush apply one coat of preservative treatment on wood in contact with cementitious materials, and roofing and related metal flashings. Treat sitesawn cuts.
   3. Allow preservative to dry prior to erecting members.

H. Preparation for Site Finishing:
   1. Site Finishing: Refer to Section 09900.
   2. Before installation, prime paint surfaces of items or assemblies to be in contact with cementitious materials.

3.4 ERECTION TOLERANCES

A. General Requirements: Quality requirements for tolerances.

B. Maximum Variation from Indicated Position: 1.5 mm.

C. Maximum Offset from Alignment with Abutting Materials: 0.7 mm.

3.5 SCHEDULES

A. As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 06401

EXTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
1. Exterior shutters.
2. Exterior standing and running trims, frames and jambs.
3. Exterior Pergolas.
4. Claustra elements.
5. Shop priming exterior woodwork.
6. Shop finishing exterior woodwork.
7. Hardware for exterior shutters.

B. Related Sections include the following:
1. Division 1 Section "LEED Requirements" for additional LEED requirements.
2. Division 6 Section "Rough Carpentry" for exposed framing.

1.3 SUBMITTALS

A. Product Data: For each type of product and process indicated and incorporated into items of exterior architectural woodwork during fabrication, finishing, and installation.
1. Include data for wood-preservative treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.
2. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.

B. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
1. Show details full size.
2. Show locations and sizes of blocking and nailers, including concealed blocking and reinforcement specified in other Sections.

C. Samples for Verification:
1. Lumber for exterior wood stain finish, not less than 300 cm^2, for each species, with 1/2 of exposed surface finished.

2. Lumber for transparent finish, not less than 300 cm², for each species, with 1/2 of exposed surface finished.
3. Lumber and panel products for shop-applied opaque finish, 200 x 250 mm for panels and 300 cm² for lumber, for each finish system and color, with 1/2 of exposed surface finished.

D. LEED Submittals:
1. Credit MR 7: Certificates of chain-of-custody signed by manufacturers certifying that products specified to be made from certified wood were made from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC 1.2, "Principles and Criteria." Include evidence that mill is certified for chain-of-custody by an FSC-accredited certification body.

E. Product Certificates: For each type of product, signed by product manufacturer.

F. Woodwork Quality Standard Compliance Certificates: AWI Quality Certification Program certificates.

G. Qualification Data: For Fabricator.

1.4 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance. Shop is a certified participant in AWI's Quality Certification Program.

B. Quality Standard: Unless otherwise indicated, comply with WI's "Manual of Millwork" for grades of exterior architectural woodwork indicated for construction, finishes, installation, and other requirements.
1. Provide WI-certified compliance labels indicating that woodwork, including installation, complies with requirements of grades specified.

C. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.

D. Forest Certification: Provide exterior architectural woodwork produced from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC 1.2, "Principles and Criteria."

1.5 PROJECT CONDITIONS

A. Weather Limitations: Proceed with installation of exterior woodwork only when existing and forecasted weather conditions permit work to be performed and at least one coat of specified finish to be applied without exposure to rain, snow, or dampness.

B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
   1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed and indicate measurements on Shop Drawings.

1.6 COORDINATION

A. Coordinate sizes and locations of framing, blocking, reinforcements, and other related units of Work specified in other Sections to ensure that exterior architectural woodwork can be supported and installed as indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide materials that comply with requirements of AWI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.

B. Wood Products: Comply with the following:
   1. Hardboard: AHA A135.4.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

A. Preservative Treatment by Non-pressure Process: Comply with AWPA N1 using the following preservative for woodwork items indicated to receive water-repellent preservative treatment:
   1. Water-Repellent Preservative/Insecticide: Formulation made specifically for dip treatment of woodwork items and containing 3-iodo-2-propynyl butyl carbamate (IPBC) as its active ingredient, combined with an insecticide containing chlorpyrifos as its active ingredient, both complying with AWPA P8.

B. Preservative Treatment by Pressure Process: AWPA C2 (lumber) and AWPA C9 (plywood) and the following:
   1. Preservative Chemicals: Acceptable to authorities having jurisdiction and containing no arsenic or chromium. Use chemical formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.

2. Kiln-dry lumber and plywood after treatment to a maximum moisture content, respectively, of 19 and 15 percent. Do not use materials that are warped or do not comply with requirements for untreated materials.
3. Mark each treated item with treatment quality mark of an inspection agency approved by the American Lumber Standards Committee Board of Review.

C. Extent of Treatment: Treat blocking and nailers by pressure process and treat other exterior architectural woodwork either by pressure or non-pressure process.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where fire-retardant-treated materials are indicated, provide materials that comply with performance requirements of AWPA C20 (lumber) and AWPA C27 (plywood), exterior type.
1. Fire-Retardant Chemicals: Use chemical formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
2. Mill lumber before treatment and implement special procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.
3. Kiln-dry materials before and after treatment to levels required for untreated materials.
4. Do not use treated materials that do not comply with requirements of referenced woodworking standard or that are warped, discolored, or otherwise defective.
5. Identify fire-retardant-treated materials with appropriate classification marking of UL, U.S. Testing, Timber Products Inspection, or another testing and inspecting agency acceptable to authorities having jurisdiction.

2.4 INSTALLATION MATERIALS

A. Blocking, Shims, and Nailers: Softwood or hardwood lumber, fire-retardant treated, kiln dried to less than 15 percent moisture content.

B. Nails: stainless steel.

C. Screws: stainless steel.
1. Provide self-drilling screws for metal framing supports, as recommended by metal-framing manufacturer.

D. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts, unless otherwise indicated. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

2.5 FABRICATION, GENERAL

A. Wood Moisture Content: 10 to 15 percent.

B. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
   1. Edges of Solid-Wood (Lumber) Members 19 mm Thick or Less: 1.6 mm.
   2. Edges of Rails and Similar Members More Than 19 mm Thick: 3 mm.

C. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.

D. Shop cut openings, to maximum extent possible, to receive hardware, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Smooth edges of cutouts and seal with a water-resistant coating suitable for exterior applications.

2.6 EXTERIOR SHUTTERS FOR TRANSPARENT FINISH

A. Work Included: Fixed louvered shutters, hinged louvered shutters, folding louvered shutters and sliding louvered shutters, as indicated on drawings.

B. AAMA/WDMA Performance Requirements: Provide wood shutters of performance indicated that comply with AAMA/WDMA 101/I.S.2/NAFS.
   1. Performance Class and Grade: R25.

C. Forced-Entry Resistance: Comply with Performance Grade 10 requirements when tested according to ASTM F 588.

D. Life-Cycle Testing: Test according to AAMA 910 and comply with AAMA/WDMA 101/I.S.2/NAFS.

E. Operating Force and Auxiliary (Durability) Tests: Comply with AAMA/WDMA 101/I.S.2/NAFS for operating window types indicated.

F. Grade: Premium.

G. Wood Species: Canadian Cedar:-

1.	Mechanical Properties		
	Young's modulus	7400 – 7900	MPa
	Tensile strength	50	MPa
	Compressive strength	29 – 35	MPa
	Bending strength	48 – 54	MPa
2.	Physical Properties		
	Thermal conductivity	0.09	W/m.K
	Density	350	kg/m³
	Shrinkage	0.6 - 1.2	%
	Water absorption	11 – 16	%
3.	Environmental Data		
	Eco indicator 95	4.17	mPt
	EPS	327	mELU
	Ex (in) / Ex (out)	2.80	MJ/MJ

GER	47.9	MJ
Raw materials input	4.31	kg
Solid	0.10	kg
Eco indicator 99	0.77	Pt

4. Do not use plain-sawn lumber with exposed, flat surfaces more than 75 mm wide.

H. Wood Species: Iroko Teak Hardwood:-

1. Mechanical Properties

Young's modulus	10500 – 15600	MPa
Tensile strength	95-155	MPa
Compressive strength	48 – 91	MPa
Bending strength	86 – 170	MPa

2. Physical Properties

Thermal conductivity	0.19 – 0.38	W/m.K
Density	630	kg/m³
Shrinkage	0.6	%

3. Environmental Data

Eco indicator 95	3.15	mPt
EPS	243	mELU
Ex (in) / Ex (out)	1.74	MJ/MJ
GER	31.8	MJ
Raw materials input	1.78	kg
Solid	0.10	kg
Eco indicator 99	0.40	Pt

4. Do not use plain-sawn lumber with exposed, flat surfaces more than 75 mm wide.

2.6 EXTERIOR STANDING AND RUNNING TRIM, FRAMES AND JAMBS FOR TRANSPARENT FINISH

A. Location: Frames, jambs and trims used for exterior wood shutters.

B. Grade: Premium.

C. Back-out or groove backs of flat trim members and kerf backs of other wide, flat members, except for members with ends exposed in finished work.

D. Assemble casings in plant except where shipping limitations require field assembly.

E. Wood Species: Same wood used for shutters.

1. Do not use plain-sawn lumber with exposed, flat surfaces more than 75 mm wide.

2.8 SHOP PRIMING

A. Woodwork for Transparent Finish: Shop seal woodwork for transparent finish with stain (if required), other required pretreatments, and first coat of finish as specified in Division 9 painting Sections:

B. Preparations for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork, as applicable to each unit of work.

1. Back-priming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork.

2.9 SHOP FINISHING

A. Grade: Premium.

B. General: Entire finish of exterior architectural woodwork is specified in this Section. To greatest extent possible, finish architectural woodwork at fabrication shop. Defer only final touchup and cleaning until after installation.

C. Preparations for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork, as applicable to each unit of work.

1. Back-priming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to surfaces installed in contact with concrete or masonry and to end-grain surfaces.

2.10 HARDWARE

A. General: Provide manufacturer's standard hardware fabricated from non-magnetic stainless steel, complying with AAMA 907, or other corrosion-resistant material compatible with wood; designed to smoothly operate, tightly close, and securely lock wood shutters, and sized to accommodate sash or ventilator weight and dimensions.

B. Hardware: Heavy duty hinges, pintles, tie-backs, slide bolts, shutter locks, pull bolts, fasteners, stays, sliding rails, and all other hardware required for proper functioning of each shutter type.

C. Counterbalancing Mechanism: Comply with AAMA 902.

D. Sill Cap/Track: Extruded-aluminum track with natural anodized finish, of thickness, dimensions, and profile indicated; designed to comply with performance requirements indicated and to drain to the exterior.

E. Locks and Latches: Designed to allow unobstructed movement of the sash across adjacent sash in direction indicated and operated from the inside only.

F. Roller Assemblies: Low-friction design.

G. Push-Bar Operators: Provide telescoping-type, push-bar operator designed to open and close ventilators with fixed screens.

H. Gear-Type Rotary Operators: Comply with AAMA 901 when tested according to ASTM E 405, Method A.

1. Operation Function: All ventilators move simultaneously and securely close at both jambs without using additional manually controlled locking devices.

I. Four- or Six-Bar Friction Hinges: Comply with AAMA 904.
   1. Locking mechanism and handles for manual operation.
   2. Friction Shoes: Provide friction shoes of nylon or other nonabrasive, non-staining, noncorrosive, durable material.

J. Limit Devices: Provide concealed friction adjustor, adjustable stay bar limit devices designed to restrict sash or ventilator opening.
   1. Safety Devices: Limit clear opening to 100 mm for ventilation; with custodial key release.

K. Pole Operators: Tubular-shaped anodized aluminum; with rubber-capped lower end and standard push-pull hook at top to match hardware design; of sufficient length to operate window without reaching more than 1500 mm above floor; 1 pole operator and pole hanger per room that has operable windows more than 1800 mm above floor.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.

B. Deliver concrete inserts and similar anchoring devices to be built into substrates well in advance of time substrates are to be built.

C. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and back-priming.

3.2 INSTALLATION

A. Quality Standard: Install woodwork to comply with same grade specified in Part 2 for type of woodwork involved.

B. Install woodwork true and straight with no distortions. Shim as required with concealed shims. Install level and plumb to a tolerance of 3 mm in 2400 mm.

C. Scribe and cut woodwork to fit adjoining work, and refinish cut surfaces or repair damaged finish at cuts.

D. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.

E. Preservative-Treated Wood: Where cut or drilled in field, treat cut ends and drilled holes according to AWPA M4.

F. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure to grounds, stripping and blocking with countersunk concealed fasteners and blind nailing. Use fine finishing nails for exposed nailing, countersunk and filled flush with woodwork.

G. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible. Do not use pieces less than 900 mm long, except where shorter single-length pieces are necessary. Scarf running joints and stagger in adjacent and related members.

1. Install standing and running trim with no more variation from a straight line than 3 mm in 2400 mm.

H. Complete finishing work specified in this Section to extent not completed at shop or before installation of woodwork. Fill nail and screw holes with matching filler where exposed.

3.3 ADJUSTING AND CLEANING

A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; replace woodwork where not possible to repair. Adjust joinery for uniform appearance.

B. Clean woodwork on exposed and semi-exposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 06401

SECTION 06402

INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:-
1. Closets in MDF construction with French Oak veneer for doors and Lamica and melamine laminate for carcasses.
2. Wall paneling in MDF with French Oak veneer finish.
3. Ceiling panels in MDF with paint and French Oak veneer finish
4. Miscellaneous woodwork.
5. Shop finishing of interior woodwork.

B. Related Sections include the following:
1. Division 1 Section "LEED Requirements" for additional LEED requirements.
2. Division 6 Section "Rough Carpentry".
3. Division 8 Section “Flush Wood Doors”.
4. Division 9 Section “Painting”.

1.3 DEFINITIONS

A. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items unless concealed within other construction before woodwork installation.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated, including cabinet hardware and accessories, handrail brackets and finishing materials and processes.

B. Product Data: For panel products high-pressure decorative laminate, adhesive for bonding plastic laminate, solid-surfacing material, fire-retardant-treated materials, cabinet hardware and accessories, handrail brackets and finishing materials and processes.
1. Include data for fire-retardant treatment from chemical treatment manufacturer and certification by treating plant that treated materials comply with requirements.

C. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.

1. Show details full size.
2. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
3. Show veneer leaves with dimensions, grain direction, exposed face, and identification numbers indicating the flitch and sequence within the flitch for each leaf.
4. Apply WI-certified compliance label to first page of Shop Drawings.

D. Samples for Initial Selection:-
1. Shop-applied transparent finishes.
2. Shop-applied opaque finishes.
3. Plastic laminates and melamine facing.
4. Wood veneer facing.
5. PVC edge material.
6. Solid-surfacing materials.

E. Samples for Verification:-
1. Lumber with or for transparent finish, not less than (125 mm) wide by (600 mm) long, for each species and cut, finished on 1 side and 1 edge.
2. Veneer leaves representative of and selected from flitches to be used for transparent-finished woodwork.
3. Veneer-faced panel products with or for transparent finish, (300 by 600 mm), for each species and cut. Include at least one face-veneer seam and finish as specified.
4. Lumber and panel products with shop-applied opaque finish, (300 sq. cm) for lumber and (200 by 250 mm) for panels, for each finish system and color, with exposed surface finished.
5. Wood veneer and plastic laminates, (200 by 250 mm), for each type, color, pattern, and surface finish, with 1 sample applied to core material and specified edge material applied to 1 edge.
6. Solid-surfacing materials, (150 mm) square.
7. Corner pieces as follows:-
   a. Cabinet-front frame joints between stiles and rails, as well as exposed end pieces, (450 mm) high by (450 mm) wide by (150 mm) deep.
   b. Miter joints for standing trim.
8. Exposed cabinet hardware and accessories, one unit for each type and finish.

F. LEED Submittals:
1. Credit EQ 4.1: Manufacturers' product data for installation adhesives, including printed statement of VOC content.
2. Credit EQ 4.4:
   a. Composite wood manufacturer's product data for each composite wood product used indicating that the bonding agent contains no urea formaldehyde.
   b. Adhesive manufacturer's product data for each adhesive used indicating that the adhesive contains no urea formaldehyde.
3. Credit(s) MR 4.1: Product Data indicating percentages by weight of postconsumer and pre-consumer recycled content for products having recycled content.
   a. Include statement indicating costs for each product having recycled content.

4. Credit MR 7: Certificates of chain-of-custody signed by manufacturers certifying that products specified to be made from certified wood were made from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC 1.2, "Principles and Criteria." Include evidence that mill is certified for chain-of-custody by an FSC-accredited certification body.

G. Product Certificates: For each type of product, signed by product manufacturer.

H. Qualification Data: For Installer and fabricator.

1.5 QUALITY ASSURANCE

A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance.

B. Installer Qualifications: Fabricator of products.

C. Source Limitations: Engage a qualified woodworking firm to assume undivided responsibility for production of interior architectural woodwork with sequence-matched wood veneers.

D. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.

E. Quality Standard: Unless otherwise indicated, comply with WI's "Manual of Millwork" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.

F. Fire-Test-Response Characteristics: Where fire-retardant materials or products are indicated, provide materials and products with specified fire-test-response characteristics as determined by testing identical products per test method indicated by UL, ITS, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify with appropriate markings of applicable testing and inspecting agency in the form of separable paper label or, where required by authorities having jurisdiction, imprint on surfaces of materials that will be concealed from view after installation.

G. Mockups: Build mockups to verify selections made under sample submittals and to d demonstrate aesthetic effects and set quality standards for materials and execution.
1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

H. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not deliver woodwork until painting and similar operations that could damage woodwork have been completed in installation areas. If woodwork must be stored in

other than installation areas, store only in areas where environmental conditions comply with requirements specified in "Project Conditions" Article.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.

B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
   1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.
   2. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating woodwork without field measurements. Provide allowance for trimming at site, and coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.8 COORDINATION

A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

B. Hardware Coordination: Coordinate Shop Drawings and fabrication with hardware requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Lumber: DOC PS 20 and applicable grading rules of inspection agencies certified by ALSC's Board of Review.
   1. Factory mark each piece of lumber with grade stamp of inspection agency indicating grade, species, moisture content at time of surfacing, and mill.
   2. For exposed lumber, mark grade stamp on end or back of each piece.

B. Wood Products: Comply with the following:-
   1. Hardboard: AHA A135.4.
   2. Medium-Density Fiberboard: ANSI A208.2, Grade 130.
   3. Softwood Plywood: DOC PS 1, Medium Density Overlay.
   4. Particleboard: ANSI A208.1, Grade M-2.

5. Melamine-Faced Particleboard: Particleboard complying with ANSI A208.1, Grade M-2, finished on both faces with thermally fused, melamine-impregnated decorative paper complying with LMA SAT-1.
6. Veneer-Faced Panel Products (Hardwood Plywood): HPVA HP –1, made with adhesive containing no urea formaldehyde.
7. Hardwood: French Oak.

C. Face Wood Veneers: are to comply with the following requirements:-
1. Grade: E to BS EN 636 Part 1, or AA to the standards of Hardwood, Plywood & Veneer Association (HPVA), USA, or the highest grade to any other International Standards approved by the Engineer.
2. Cut: Sliced; plain, quarter or rift according to the pattern selected by the Engineer, for veneer leaves.
3. Species: French Oak veneer.
4. Length of leaves: is to be long enough to cover the height of the work item finished with veneer, unless otherwise end-matched pattern is selected by the Engineer.
5. Matching of leaves through Face: as selected by the Engineer, where use of more than one leaf is unavailable.
6. Veneer leaves for Faces: are to be from flitch and conform to the assignment elected by the Engineer.
7. Width of leaves: Width of leaves face for elevation is to be as required to attain the matching-through-elevation selected by the Engineer at minimum number of leaves.
8. Treatment: No fire retardant treatment is required for face veneers. Preservative treatment is to be with material to BS 5707, copper, chrome or arsenic based. Preservative treatment is not to change or effect the characteristics of face veneer.
9. Finish: as indicated on drawings.

D. Plastic Laminate: National Electrical Manufacturers Association NEMA LD 3-91 “High Pressure Decorative Laminates”, GP-50, color and pattern as follows:-
1. Material: Minimum 0.9mm thick "Formica", "Polyrey" or equal approved by Engineer.
2. Color and Pattern: shall be selected by Engineer from manufacturer’s full range of colors and patterns.

E. Metal Supports and Reinforcement:
1. Steel Sub-frame Members: ASTM A 36, structural-quality steel members as required for support and reinforcement

2.2 CABINET HARDWARE AND ACCESSORIES

A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets that comply with BHMA A156.9.

B. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.

C. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.

2.3 FIRE-RETARDANT-TREATED MATERIALS

A. General: Where indicated, use materials impregnated with fire-retardant chemical formulations indicated by a pressure process or other means acceptable to authorities having jurisdiction to produce products with fire-test-response characteristics specified.

1. Do not use treated material that does not comply with requirements of referenced woodworking standard or that is warped, discolored, or otherwise defective.
2. Use fire-retardant-treatment formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants in solution to distinguish treated material from untreated material.

B. Fire-Retardant-Treated Lumber and Plywood by Pressure Process: Comply with AWPA C20 (lumber) and AWPA C27 (plywood), for woodwork items indicated as fire-retardant treated. Use the following treatment type:

1. Exterior Type: Organic-resin-based formulation thermally set in wood by kiln-drying.
2. Mill lumber before treatment and implement special procedures during treatment and drying processes that prevent lumber from warping and developing discolorations from drying sticks or other causes, marring, and other defects affecting appearance of treated woodwork.
3. Kiln-dry material before and after treatment to levels required for untreated material.

C. Fire-Retardant-Treated Lumber and Plywood by Non-pressure Process: Apply nontoxic, water-soluble, fire-retardant treatment by dip, spray, roller, curtain coating, vacuum chamber, or soaking to achieve flame-spread rating of 25 or less and smoke-developed rating of 450 or less per ASTM E 84.

D. Fire-Retardant Particleboard: Panels complying with the following requirements, made from softwood particles and fire-retardant chemicals mixed together at time of panel manufacture to achieve flame-spread rating of 25 or less and smoke-developed rating of 25 or less per ASTM E 84.

1. For panels 19 mm thick and less, comply with ANSI A208.1 for Grade M-2 except for the following minimum properties: density, 720-kg/cu. M; modulus of rupture, 11 MPa; modulus of elasticity,
2. For panels 20 to 32 mm thick, comply with ANSI A208.1 for Grade M-1 except for the following minimum properties: density, 705-kg/cu. m; modulus of rupture, 9 MPa; modulus of elasticity, 1700 MPa; linear expansion, 0.50 percent; and screw-holding capacity on face and edge, 780 N, respectively.

2.4 MISCELLANEOUS MATERIALS

A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.

B. Furring, Blocking, Shims, and Hanging Strips: Fire-retardant-treated softwood lumber, kiln dried to less than 15 percent moisture content.

C. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

D. Adhesives, General: Do not use adhesives that contain urea formaldehyde.

E. VOC Limits for Installation Adhesives and Glues: Use installation adhesives that comply with the following limits for VOC content when calculated according to 40 CFR 59, Subpart D (EPA Method 24):
   1. Wood Glues: 30 g/L.
   2. Contact Adhesive: 250 g/L.

2.5 FABRICATION, GENERAL

A. Interior Woodwork Grade: Unless otherwise indicated, provide Premium-grade interior woodwork complying with referenced quality standard.

B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.

C. Sand fire-retardant-treated wood lightly to remove raised grain on exposed surfaces before fabrication.

D. Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to radius indicated for the following:
   1. Corners of Cabinets and Edges of Solid-Wood (Lumber) Members (19 mm) Thick or Less: (1.5 mm).
   2. Edges of Rails and Similar Members More Than (19 mm) Thick: (3 mm).
   3. Corners of Cabinets and Edges of Solid-Wood Members and Rails: (1.5 mm).

E. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
   1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.

F. Shop-cut openings to maximum extent possible to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
   1. Seal edges of openings in countertops with a coat of varnish.

2.6 MANUFACTURED UNITS

A. Provide manufactured units with dimensions, spacing details and anchorage as detailed. Provide brackets and fittings for installation.

2.7 SHOP FINISHING

A. Grade: Provide finishes of same grades as items to be finished.

B. General: Finish architectural woodwork at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.

C. General: Shop finish transparent-finished interior architectural woodwork at fabrication shop as specified in this Section. Refer to Division 9 painting Sections for finishing opaque-finished architectural woodwork.

D. General: Drawings indicate items that are required to be shop finished. Finish such items at fabrication shop as specified in this Section. Refer to Division 9 painting Sections for finishing architectural woodwork not indicated to be shop finished.

E. Shop Priming: Shop apply the prime coat including back-priming, if any, for transparent-finished items specified to be field finished. Refer to Division 9 painting Sections for material and application requirements.

F. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork, as applicable to each unit of work.

1. Back-priming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to back of paneling and to end-grain surfaces. Concealed surfaces of plastic-laminate-clad woodwork do not require back-priming when surfaced with plastic laminate, backing paper, or thermo-set decorative panels.

G. Transparent Finish:-

1. Grade: Premium.
2. Staining: Match approved sample for color.
3. Wash Coat for Stained Finish: Apply wash-coat sealer to woodwork made from closed-grain wood before staining and finishing.
4. Open Finish for Open-Grain Woods: Do not apply filler to open-grain woods.
5. Filled Finish for Open-Grain Woods: After staining (if any), apply paste wood filler to open-grain woods and wipe off excess. Tint filler to match stained wood.
   a. Apply wash-coat sealer after staining and before filling.
6. Sheen: Gloss units measured on 60-degree gloss meter per ASTM D 523.

H. Opaque Finish:

1. Grade: Premium.
2. Color: Match 's sample.
3. Sheen: Gloss units measured on 60-degree gloss meter per ASTM D 523.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.

B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and back-priming.

3.2 INSTALLATION

A. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.

B. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.

C. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of (3 mm in 2400 mm).

D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

E. Fire-Retardant-Treated Wood: Handle, store, and install fire-retardant-treated wood to comply with chemical treatment manufacturer's written instructions, including those for adhesives used to install woodwork.

F. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails or finishing screws for exposed fastening, countersunk and filled flush with woodwork and matching final finish if transparent finish is indicated.

G. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible. Do not use pieces less than (900 mm) long, except where shorter single-length pieces are necessary. Scarf running joints and stagger in adjacent and related members.
   1. Fill gaps, if any, between top of base and wall with plastic wood filler, sand smooth, and finish same as wood base if finished.
   2. Install wall railings on indicated metal brackets securely fastened to wall framing.
   3. Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches (3 mm in 2400 mm).

H. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.

1. Install cabinets with no more than (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
2. Maintain veneer sequence matching of cabinets with transparent finish.
3. Fasten wall cabinets through back, near top and bottom, at ends and not more than (400 mm) o.c. with No. 10 wafer-head screws sized for (25-mm) penetration into wood framing, blocking, or hanging strips, No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish, toggle bolts through metal backing or metal framing behind wall finish.

I. Touch up finishing work specified in this Section after installation of woodwork. Fill nail holes with matching filler where exposed.

J. Refer to Division 9 Sections for final finishing of installed architectural woodwork not indicated to be shop finished.

3.3 ADJUSTING AND CLEANING

A. Repair damaged and defective woodwork, where possible, to eliminate functional and visual defects; where not possible to repair, replace woodwork. Adjust joinery for uniform appearance.

B. Clean, lubricate, and adjust hardware.

C. Clean woodwork on exposed and semi exposed surfaces. Touch up shop-applied finishes to restore damaged or soiled areas.

END OF SECTION 06402

SECTION 06410

CUSTOM CABINETS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes custom-fabricated cabinet units; counter tops; cabinet hardware; preparation for installing utilities in cabinets; and shop and/or site finishing.

B. Related Sections:
1. Section 06200 - Finish Carpentry: Related trim not specified in this section.
2. Section 08800 - Glazing: Glass for casework.
3. Section 09900 - Paints and Coatings: Site finishing of cabinet, exterior and interior.
4. Division 15 - Mechanical: Under-top stainless steel sink, mixers, robinet, angle valves and all required mechanical installations.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI A156.9 - Cabinet Hardware.
2. ANSI A208.1 - Mat-Formed Wood Particleboard.

B. Architectural Woodwork Institute:
1. AWI - Quality Standards Illustrated.

C. Federal Specification Unit:
1. FS A-A-1936 - Adhesive, Contact, Neoprene Rubber.

D. National Electrical Manufacturers Association:
1. NEMA LD 3 - High Pressure Decorative Laminates.

E. Woodwork Institute of California:
1. WIC - Manual of Millwork.

F. ASTM International:
1. ASTM A666 - Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

1.3 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

B. Shop Drawings: Indicate materials, component profiles and elevations, assembly methods, joint details, fastening methods, accessory listings, hardware location and schedule of finishes.

C. Product Data: Submit data for hardware accessories.

D. Samples:
   1. Submit two samples, each size 200 x 250 mm illustrating cabinet finish.
   2. Submit two samples each size 200 x 250 mm illustrating counter top finish.
   3. Submit two samples of drawer pulls, hinges, etc. illustrating hardware finish.

E. Certification: Submit copy of fabricator's authorization to use AWI Grade Stamps, AWI Quality Certification Program license and Project specific letters and/or WIC certified compliance certificate.

1.4 QUALITY ASSURANCE

A. Perform work in accordance with AWI (Architectural Woodwork Institute) Architectural Woodwork Quality Standards Illustrated, Economy, Custom and/or Premium Grade, and/or WIC (Woodwork Institute of California) Manual of Millwork, Economy, Custom and/or Premium Grade.

B. Maintain one copy of each document on site.

1.5 QUALIFICATIONS

A. Fabricator: Company specializing in performing Work of this section with minimum ten years documented experience.

1.6 MOCKUP

A. General Requirements: Quality requirements for mockup.

B. Construct mockup of full size base cabinet and upper cabinet including plumbing and electrical fixtures, hardware, accessories and fitments.

C. Locate where directed by the Engineer.

D. Remove mockup when directed by the Engineer.

1.7 PRE-INSTALLATION MEETINGS

A. General Requirements: Administrative requirements for pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

A. General Requirements: Product requirements for product storage and handling.

B. Protect units from moisture damage.

1.9 ENVIRONMENTAL REQUIREMENTS

A. General Requirements: Product requirements.

B. During and after installation of Work of this section, maintain same temperature and

humidity conditions in building spaces as will occur after occupancy.

1.10 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 CUSTOM CABINETS

A. Manufacturer: Any internationally recognized manufacturer having an official technical agreement to conformity with standards for the product.

2.2 COMPONENTS

A. Softwood and/or Hardwood Lumber: AWI Grade III, II and/or I; and/or WIC Economy, Custom and/or Premium Grade; maximum moisture content of 6-8 percent;

B. Softwood and/or Hardwood Plywood: AWI Grade B, A and/or AA veneer; and/or WIC Economy, Custom and/or Premium veneer; with particleboard, medium density fiberboard, veneer and/or lumber core; type of glue recommended for application;

C. Wood Particleboard: ANSI A208.1 Type 1 and/or 2; composed of wood chips or sawdust, medium density, made with water resistant adhesive; sanded faces.

D. High Pressure Decorative Laminate: NEMA LD 3, GP50 for horizontal surfaces, GP28 for vertical surfaces, CL20 for cabinet liner surfaces, BK20 for undecorated backing sheets, PF42 for post forming, and/or FR50 for fire-retardant surfaces; Color, pattern, and surface texture as selected and/or indicated on drawings.

E. Sheet Metal Components: Stainless steel, Type 316 with #4 satin and/or #8 polished finish;

F. Synthetic Surfacing: Synthetic marble of polyester and/or proprietary resins, stain resistant to domestic chemicals and cleaners and as per approved codes and standards.

G. Counter Tops, Back Splash and Side Splash: As per schedule stated hereinafter or as shown on drawings.

H. Service Fittings for Kitchen Cupboards: As per schedule stated hereinafter or as shown on drawings.

I. Electrical Built-in Appliances in Kitchen Cupboards: As per schedule stated hereinafter or as shown on drawings.

2.3 ACCESSORIES

A. Adhesive for High Pressure Decorative Laminates: FS A-A-1936 contact adhesive. Type recommended by laminate manufacturer to suit application.

B. Veneer Edge Band: Standard wood veneer edge band matching face veneer.

C. Plastic Edge Trim: Extruded convex and/or flat shaped; smooth and/or ridged finish; self locking serrated tongue; of width to match component thickness; color as selected and/or as indicated on drawings.

D. Aluminum Edge Trim: Extruded convex and/or flat shape; smooth and/or ridged surface finish; self locking serrated tongue; of width to match component thickness; natural mill, clear anodized and/or bronze anodized finish.

E. Glass: As specified in Section 08800.

F. Fasteners: Size and type to suit application.

G. Bolts, Nuts, Washers, Lags, Pins, and Screws: Of size and type to suit application; galvanized finish in concealed locations and stainless steel type 316 finish in exposed locations.

H. Bolts: Steel and comply with BS916

I. Washers: to BS3410, part 2.

J. Screws:
1. All steel screws shall be finished to resist corrosion by sherardizing, cadmium plating, nickel plating or other approved finish.
2. Screws shall be protected steel, stainless steel type 316, brass silicone bronze, nickel/copper alloy or aluminum as specified on drawings or as appropriate to the work. Screws for fixing hardware shall match the items being fixed.
3. Screw heads shall be for the generality of the work, countersunk slotted. Screw heads in the finished work shall, unless otherwise described, be brass, bronzed finish with matching fully countersunk brass cups. Phillips crosshead screws or pozidrive screws shall be used where so described on drawings.

K. Concealed Joint Fasteners: Threaded steel.

L. Grommets: Plastic, Metal and/or Rubber material for cut-outs.

M. Hardware:
1. Hinges: Plain bearing two knuckle stainless steel type 316 hinges (3 No. per door leaf).
2. Knob for door panels as selected (1 No. per door leaf).
3. Perforations: 25mm diameter to act instead of knobs where indicated.
4. Lock: Cabinet lock for each door panel or couple of panels as appropriate with security cylinder and with two keys for each lock.
5. Knob for drawer as selected (1 No. per drawer).
6. Drawer runners: Steel telescopic runners (full width of drawer on both sides).
7. Chrome pins for adjustable shelves.
8. Chrome hanging rods.

N. Shelf Standards and Rests: Formed steel channels and rests, cut for fitted rests spaced

as indicated; chrome and/or satin finish.

O. Shelf Brackets: Formed steel brackets, formed for attachment with lugs; chrome and/or satin finish.

P. Drawer and Door Pulls: Extruded aluminum pull, full width of drawer, polished and/or satin finish, "U" shaped pull, steel with chrome and/or satin finish, aluminum with polished and/or satin finish, bronze with satin finish, and/or plastic of color as selected.

Q. Sliding Door Pulls: Circular, Oval and/or Elongated shape, steel with chrome and/or satin finish, aluminum with polished and/or satin finish, bronze with satin finish, and/or plastic of color as selected.

R. Catches: Type as indicated on drawings.

S. Drawer Slides: Galvanized steel construction, ball bearings separating tracks, full extension type.

T. Sliding Door Track Assemblies: Galvanized steel construction, ball bearing carriers fitted within tracks, multiple pendant suspension attachments for door.

2.4 FABRICATION

A. Shop assemble casework for delivery to site in units easily handled and to permit passage through building openings.

B. Fit shelves, doors, and exposed edges with matching veneer, plastic and/or aluminum edging. Use one piece for full length only.

C. Cap exposed high pressure decorative laminate finish edges with material of same finish and pattern.

D. Door and Drawer Fronts: 19 mm thick; flush, overlay and/or reveal overlay style.

E. When necessary to cut and fit on site, fabricate materials with ample allowance for cutting. Furnish trim for scribing and site cutting.

F. Apply high pressure decorative laminate finish in full uninterrupted sheets consistent with manufactured sizes. Fit corners and joints hairline; secure with concealed fasteners. Locate counter butt joints minimum 600 mm from sink cut-outs.

G. Apply wood laminate by grain matching adjacent sheets to book, slip, random and/or end matching.

H. Apply laminate backing sheet to reverse side of plastic and/or wood laminate finished surfaces.

I. Fabricate metal counter top surfaces pressure glued to plywood or particle board core backing with butt or welded joints, or without visible joints.

J. Mechanically fasten back splash to counter tops with steel brackets at 400 mm on center.

K. Fabricate cabinets and counter tops with cutouts for plumbing fixtures, inserts, appliances, outlet boxes, and fixtures and fittings. Verify locations of cutouts from on-site dimensions. Prime paint and/or Seal cut edges.

L. Shop glaze glass materials using Interior Dry, Combination and/or Wet method specified in Section 08800.

2.5 SHOP FINISHING

A. Sand work smooth and set exposed nails and screws.

B. Apply wood filler in exposed nail and screw indentations.

C. On items to receive transparent finishes, use wood filler matching surrounding surfaces and of types recommended for applied finishes.

D. Finish work in accordance with AWI - Section 1500 Finish System Transparent and/or Opaque.

E. Finish work in accordance with WIC - Section 25 System (#1) (#2) (#3) (#4) (#5) (#6) (#7) (#8).

F. Stain, seal and varnish exposed to view surfaces. Brush and/or Spray apply only.

G. Seal and/or stain and varnish internal exposed to view and semi-concealed surfaces.

H. Seal internal surfaces of cabinets.

I. Prime paint and/or Seal surfaces in contact with cementitious materials.

J. Finish in accordance with Section 09900.

PART 3 EXECUTION

3.1 EXAMINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Verify adequacy of backing and support framing.

C. Verify location and sizes of utility rough-in associated with work of this section.

3.2 INSTALLATION

A. Set and secure casework in place; rigid, plumb and level.

B. Use fixture attachments in concealed locations for wall mounted components.

C. Use concealed joint fasteners to align and secure adjoining cabinet units, counter tops etc.

D. Carefully scribe casework abutting other components, with maximum gaps of 1 mm. Do not use additional overlay trim for this purpose.

E. Secure cabinet and counter bases to floor using appropriate angles and anchorages.

F. Countersink anchorage devices at exposed locations. Conceal with solid wood plugs of species to match surrounding wood; finish flush with surrounding surfaces.

G. Site glaze glass materials using Interior Dry, Combination or Wet method specified in Section 08800.

3.3 ADJUSTING

A. General Requirements: Execution requirements for testing, adjusting and balancing.

B. Adjust moving or operating parts to function smoothly and correctly.

3.4 CLEANING

A. General Requirements: Execution requirements for final cleaning.

B. Clean casework, counters, shelves, hardware, fittings and fixtures.

3.5 SCHEDULES

A. As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 07130

SHEET WATERPROOFING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes waterproofing membrane, drainage panels and protective cover.

B. Related Sections:
1. Section 02320 - Backfill.
2. Section 07212 - Board Insulation.
3. Section 07620 - Sheet Metal Flashing and Trim.
4. Section 07900 - Joint Sealers.
5. Division 15 - Mechanical: Plumbing fixtures and plumbing specialties.

1.2 REFERENCES

A. ASTM International:
1. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers -Tension.
2. ASTM D449 - Standard Specification for Asphalt Used in Dampproofing and Waterproofing.
3. ASTM D450 - Standard Specification for Coal-Tar Pitch Used in Roofing, Dampproofing, and Waterproofing.
4. ASTM D471 - Standard Test Method for Rubber Property-Effect of Liquids.
5. ASTM D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
6. ASTM D746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
7. ASTM D822 - Standard Practice for Conducting Tests on Paint and Related Coatings and Materials Using Filtered Open-Flame Carbon-Arc Exposure Apparatus.
8. ASTM D1004 - Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
9. ASTM D2240 - Standard Test Method for Rubber Property-Durometer Hardness.
10. ASTM D2581 - Standard Specification for Polybutylene (PB) Plastics Molding and Extrusion Materials.
11. ASTM D4068 - Standard Specification for Chlorinated Polyethylene (CPE) Sheeting for Concealed Water-Containment Membrane.
12. ASTM D4551 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Flexible Concealed Water-Containment Membrane.
13. ASTM D4637 - Standard Specification for EPDM Sheet Used in Single-Ply Roof Membrane.
14. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.

B. National Roofing Contractors Association:
1 NRCA - The NRCA Waterproofing and Dampproofing Manual.

1.3 SYSTEM DESCRIPTION

A. Waterproofing System: Capable of resisting existing water head with the required factor of safety and preventing moisture migration to interior.

1.4 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

B. Shop Drawings: Indicate special joint or termination conditions and conditions of interface with other materials.

C. Product Data: Submit data for surface conditioner, flexible flashings, joint cover sheet, and joint and crack sealants, with temperature range for application of waterproofing membrane.

D. Manufacturer's Installation Instructions: Submit special procedures and perimeter conditions requiring special attention.

E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with NRCA Waterproofing Manual.

B. Test material samples in accordance with ASTM D449 and ASTM D450.

C. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Membrane Manufacturer: Company specializing in waterproofing sheet membranes with minimum fifteen years documented experience.

B. Applicator: Company specializing in performing work of this section with minimum ten years documented experience.

1.7 MOCKUP

A. General Requirements: Quality requirements for mockup.

B. Construct Mockup, 10 m^2 of horizontal and vertical panels; to represent finished work with internal and external corners, seam jointing, attachment method, counterflashing cover, drainage panel, base flashings, control/expansion joints, and protective cover.

C. Locate where directed by the Engineer.

D. Remove mockup when directed by the Engineer.

1.8 PRE-INSTALLATION MEETINGS

A. General Requirements: Administrative requirements for pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.9 ENVIRONMENTAL REQUIREMENTS

A. General Requirements: Product requirements.

B. Maintain ambient temperatures above 5ºC for 24 hours before and during application and until liquid or mastic accessories have cured.

1.10 WARRANTY

A. General Requirements: Execution requirements for product warranties and bonds.

B. Provide ten year warranty for each waterproofing system including coverage of materials and installation, and all resulting damage resulting from failure to resist penetration of moisture.

C. For warranty repair work, remove and replace materials concealing waterproofing.

PART 2 PRODUCTS

2.1 SHEET MEMBRANE WATERPROOFING

A. Manufacturer: Any internationally recognized manufacturer having an official technical agreement to conformity with standards for the product.

2.2 COMPONENTS

A. Rubber Membrane: Butylene conforming to ASTM D2581, EPDM conforming to ASTM D4637 Type I and/or Chloroprene/neoprene conforming to ASTM D4637 Type II; 1.8 mm thick; Class SR: Scrim or fabric internal reinforced, exposed face color and roll width as per manufacturer's recommendations; with compatible seam tape and termination bar; conforming to following below criteria:

B. Plastic Membrane: PVC conforming to ASTM D4551, HDPE, Ethylene Copolymer, CPE conforming to ASTM D4068, CSPE conforming to ASTM D4068, and/or Hypalon; thickness and roll width as per manufacturer's recommendations; with compatible seam tape and termination bar; conforming to following below criteria.

C. Modified Bituminous Membrane: Asphalt and polymer modifiers of styrenebutadiene-styrene (SBS), and/or atactic polypropylene (APP) type, reinforced with non-woven polyester, fiber glass, polyethylene and/or polypropylene; smooth surfaced; thickness and roll width as per manufacturer's recommendations; with compatible seam tape and termination bar; conforming to following below criteria.

D. Composite HDPE/Bentonite Sheet Membrane: Comprised of black/grey or clear HDPE and granular bentonite with spun polypropylene fabric facing; minimum thickness of 3.8 mm; 1200 mm wide roll; with compatible water stop devices, 100 mm wide rubberized asphalt seam tape, and extruded aluminum termination bar; conforming to following below criteria.

E. Criteria:

1.

Properties		Test
a.	Tensile Strength	ASTM D412
b.	Elongation	ASTM D412
c.	Hardness - Shore A	ASTM D2240
d.	Tear Strength	ASTM D624 and/or D1004
e.	Water Absorption	ASTM D471
f.	Moisture Vapor (perms)	ASTM E96
g.	Exposure at Low Temperature	ASTM D822
h.	Brittleness	ASTM D746

F. Seaming Materials: As recommended by membrane manufacturer.

G. Flexible Flashings: As recommended by membrane manufacturer.

2.3 ACCESSORIES

A. Surface Conditioner: type compatible with membrane, as recommended by membrane manufacturer.

B. Adhesives: As recommended by membrane manufacturer.

C. Thinner and Cleaner: As recommended by adhesive manufacturer, compatible with sheet membrane.

D. Battens: As recommended by membrane manufacturer.

E. Disc Washers and Screws: As recommended by membrane manufacturer.

F. Circular Membrane Discs: As recommended by membrane manufacturer.

G. Reglet Strip Devices: As recommended by membrane manufacturer.

H. Sealant: As stated in Section 07900 and as recommended by membrane manufacturer.

I. Mortar Beveled Corners (Fillet) at Intersections:

1. Portland Cement: ASTM C150, Type I, gray color.
2. Fine Aggregate: ASTM C144 and/or C404.
3. Water: Clean and potable.
4. Calcium chloride is not permitted.
5. Thoroughly mix mortar ingredients in accordance with ASTM C270 in quantities needed for immediate use.
6. Achieve uniformly damp sand immediately before mixing process.
7. Add admixtures in accordance with manufacturer’s instructions to achieve uniformity of mix and coloration.

8. Re-temper only within two hours of mixing.

J. Protective Covers:
1. For Horizontal Surfaces: Unless otherwise stated or shown on the drawings, heavy duty rigid polypropylene protection boards specified in Section 07212, or cement sand screed, mix (1:3).
2. For Vertical Surfaces: Unless otherwise stated or shown on the drawings, heavy duty rigid polypropylene protection boards specified in Section 07212.

K. Cant Strips: Premolded composition material and/or Bitumen impregnated fiberboard.

L. Flexible Flashings: As recommended by membrane manufacturer.

M. Counterflashings: as specified in Section 07620.

PART 3 EXECUTION

3.1 EXAMINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Verify substrate surfaces are durable; free of matter detrimental to adhesion or application of waterproofing system.

C. Verify items penetrating surfaces to receive waterproofing are securely installed.

D. Verify substrate surface slopes to drain for horizontal waterproofing applications.

3.2 PREPARATION

A. Protect adjacent surfaces not designated to receive waterproofing.

B. Clean and prepare surfaces to receive waterproofing.

C. Execute cement sand mortar at all intersections to make beveled corners (fillet) of size 50 x 50 mm.

D. Do not apply waterproofing to surfaces unacceptable to manufacturer or applicator.

E. Seal cracks and joints with sealant materials using depth to width ratio as recommended by sealant manufacturer and in accordance with Section 07900.

F. Apply surface conditioner at rate recommended by manufacturer. Protect conditioner from rain or frost until dry.

3.3 INSTALLATION - GENERAL

A. Install Work in accordance with the drawings, to the manufacturer’s instructions and to the approval of the Engineer.

3.4 INSTALLATION - LOOSE LAID MEMBRANE WATERPROOFING

A. Roll out membrane. Minimize wrinkles and bubbles.

B. Overlap edges and ends and seal by solvent welding, heat welding, contact tape and/or contact adhesive, minimum 75 mm. Seal permanently waterproof. Apply uniform bead of sealant to joint edge.

C. Reinforce membrane with multiple thicknesses of membrane material over static or moving joints.

D. Weather lap joints on sloped substrate in direction of drainage. Seal joints and seams.

E. Install flexible flashings. Seal watertight to membrane.

F. Seal flashings to adjoining surfaces.

G. Extend membrane over cants and up intersecting surfaces at membrane perimeter minimum 150 mm above horizontal surface for first ply and as recommended by the manufacturer at subsequent plies laid in shingle fashion.

H. Terminate top edge of membrane and flexible flashing under counterflashings, seal with mastic. Coordinate with metal flashing installation specified in Section 07620.

3.5 INSTALLATION - ADHESIVE BONDED, SELF ADHERED AND TORCH APPLIED MEMBRANE WATERPROOFING

A. Roll out membrane. Minimize wrinkles and bubbles.

B. Remove release paper layer. Roll out on substrate with mechanical roller to encourage full contact bond.

C. Apply adhesive at rate recommended by manufacturer, Bond sheet to substrate except those areas directly over or within 75 mm of control or expansion joint.

D. Apply membrane by torch application, coated side down.

C. Lap sides and ends.

F. Overlap edges and ends and seal with contact adhesive, or by heat sealing, minimum 75 mm. Seal permanently waterproof. Apply uniform bead of sealant to joint edge.

G. Reinforce membrane with multiple thickness of membrane material over joints, whether joints are static or dynamic.

H. Weather lap joints on sloped substrate in direction of drainage. Seal joints and seams. Coordinate with drain installation, Division 15 - Mechanical.

I. Install flexible flashings. Seal watertight to membrane.

J. Seal membrane and flashings to adjoining surfaces.

K. Extend membrane over cants and up intersecting surfaces at membrane perimeter minimum 150 mm above horizontal surface for first ply and as recommended by the manufacturer at subsequent plies laid in shingle fashion.

L. Seal items protruding to or penetrating through membrane and install Counterflashing membrane material.

3.6 INSTALLATION - MECHANICALLY ATTACHED MEMBRANE WATERPROOFING

A. Roll out membrane. Minimize wrinkles and bubbles.

B. Install mechanical fasteners in accordance with applicable code.

C. Bond sheet to membrane disc.

D. Overlap edges and ends and seal by solvent welding, heat welding, contact tape and/or contact adhesive, minimum 75 mm. Seal permanently waterproof. Apply uniform bead of sealant to joint edge.

E. Weather lap joints on sloped substrate in direction of drainage. Seal joints and seams.

F. Install flexible flashings. Seal watertight to membrane.

G. Seal membrane and flashings to adjoining surfaces.

H. Extend membrane over cants and up intersecting surfaces at membrane perimeter minimum 150 mm above horizontal surface for first ply and as recommended by the manufacturer at subsequent plies laid in shingle fashion.

I. Seal items protruding to or penetrating through membrane and install Counterflashing membrane material.

3.7 INSTALLATION - DRAINAGE PANEL AND PROTECTION BOARD

A. Place drainage panel directly against membrane, butt joints, place to encourage drainage downward.

B. Place protection board directly against drainage panel and/or membrane; butt joints.

C. Adhere protection board and drainage panel to substrate with mastic to tacky dampproofing surface. Scribe and cut boards around projections, penetrations, and interruptions.

3.8 FIELD QUALITY CONTROL

A. General Requirements: Quality requirements for testing and inspection services, and execution requirements for testing, adjusting and balancing.

B. On completion of horizontal membrane installation, dam installation area in

preparation for flood testing.

C. Flood to minimum depth of 25 mm with clean water. After 48 hours, inspect for leaks.

D. When leaking is found, remove water, repair leaking areas with new waterproofing materials as directed by the Engineer; repeat flood test. Repair damage to building.

E. When area is proven watertight, drain water and remove dam.

3.9 PROTECTION OF INSTALLED CONSTRUCTION

A. General Requirements: Execution requirements for protecting installed construction.

B. Do not permit traffic over unprotected or uncovered membrane.

C. Protect membrane from damage by adhering protection board over membrane surface. Scribe and cut boards around projections and interruptions.

3.10 SCHEDULES

A. As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 07140

FLUID-APPLIED WATERPROOFING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes fluid applied rubberized asphalt and/or elastomeric membrane waterproofing; and surface dusting and/or protective covering.

B. Related Sections:
1. Section 02320 - Backfill.
2. Section 07212 - Board Insulation: Perimeter and horizontal insulation protective cover.
3. Section 07620 - Sheet Metal Flashing and Trim.
4. Section 07900 - Joint Sealers.
5. Division 15 - Mechanical: Plumbing fixtures and plumbing specialties.

1.2 REFERENCES

A. ASTM International:
1. ASTM C836 - Standard Specification for High Solids Content, Cold Liquid-Applied Elastomeric Waterproofing Membrane for Use with Separate Wearing Course.
2. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Rubbers and Thermoplastic Elastomers -Tension.
3. ASTM D429 - Standard Test Method for Rubber Property - Adhesion to Rigid Substrates.
4. ASTM D471 - Standard Test Method for Rubber Property - Effect of Liquids.
5. ASTM D624 - Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
6. ASTM D746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
7. ASTM D822 - Standard Practice for Conducting Tests on Paint and Related Coatings and Materials Using Filtered Open-Flame Carbon-Arc Exposure Apparatus.
8. ASTM D1004 - Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
9. ASTM D2240 - Standard Test Method for Rubber Property-Durometer Hardness.
10. ASTM D3468 - Standard Specification for Liquid-Applied Neoprene and Chlorosulfonated Polyethylene Used in Roofing and Waterproofing.
11. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.

B. National Roofing Contractors Association:
1. NRCA - The NRCA Waterproofing and Dampproofing Manual.

1.3 SYSTEM DESCRIPTION

A. Waterproofing System: Fluid applied material to prevent moisture migration to interior.

1.4 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

B. Shop Drawings: Indicate special joint or termination conditions and conditions of interface with other materials.

C. Product Data: Submit data for surface conditioner, flexible flashings, joint cover sheet, and joint and crack sealants, with temperature range for application of waterproofing membrane.

D. Manufacturer's Installation Instructions: Submit special procedures and perimeter conditions requiring special attention.

E. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with NRCA Waterproofing Manual.

B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Waterproofing Material Manufacturer: Company specializing in waterproofing membrane with minimum fifteen years documented experience.

B. Applicator: Company specializing in performing the work of this section with minimum ten years documented experience.

1.7 MOCKUP

A. General Requirements: Quality requirements for mockup.

B. Construct Mockup, 10 sq m of horizontal and vertical waterproofed panel; to represent finished work including internal and external corners, jointing, attachment method, flashings, drainage panel, base flashings, control and expansion joints, and protective cover.

C. Locate where directed by the Engineer.

D. Remove mockup when directed by the Engineer.

1.8 PRE-INSTALLATION MEETINGS

A. General Requirements: Administrative requirements for pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.9 ENVIRONMENTAL REQUIREMENTS

A. General Requirements: Product requirements.

B. Maintain ambient temperatures above 5 ºC for 24 hours before and during application and until liquid or mastic accessories have cured.

1.10 WARRANTY

A. General Requirements: Execution requirements for product warranties and bonds.

B. Furnish ten year manufacturer warranty for waterproofing failing to resist penetration of water.

C. For warranty repair work, remove and replace materials concealing waterproofing.

PART 2 PRODUCTS

2.1 FLUID APPLIED WATERPROOFING

A. Manufacturer: Any internationally recognized manufacturer having an official technical agreement to conformity with standards for the product.

2.2 COMPONENTS

A. Waterproofing Membrane: Fluid; cold applied; quick setting.

B. Cured Membrane Characteristics:

1.

	Properties	Test
a.	Tensile Strength	ASTM D412
b.	Elongation	ASTM D412
c.	Hardness - Shore A	ASTM D2240
d.	Tear Strength	ASTM D624 and/or D1004
e.	Water Absorption	ASTM D471
f.	Moisture Vapor (perms)	ASTM E96
g.	Exposure at Low Temperature	ASTM D822
h.	Brittleness	ASTM D746
i.	Adhesion	ASTM D429

2.3 ACCESSORIES

A. Surface Conditioner and/or Primer: type compatible with membrane compound; as recommended by membrane manufacturer.

B. Elastic Flashings: 1.2 mm thick, as recommended by membrane manufacturer.

C. Joint Cover Sheet: Elastic sheet material designated for and compatible with membrane. Thickness as recommended by membrane manufacturer.

D. Cant Strips: Premolded composition material, as recommended by membrane manufacturer.

E. Drainage Panel: As recommended by membrane manufacturer.

F. Joint and Crack Sealant: As recommended by membrane manufacturer.

G. Back-up Material: As recommended by membrane manufacturer.

H. Reglet Strip Devices: As recommended by membrane manufacturer.

I. Counterflashings: As recommended by membrane manufacturer.

J. Tack-free Surfacing: Type 1 Portland cement and/or Stone dust.

K. Separation Sheet: As recommended by membrane manufacturer.

L. Protection Board: Rigid insulation specified in Section 07212.

PART 3 EXECUTION

3.1 EXAMINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Verify substrate surfaces are free of frozen matter, dampness, loose particles, cracks, pits, projections, penetrations, or foreign matter detrimental to adhesion or application of waterproofing system.

C. Verify substrate surfaces are smooth, free of honeycomb or pitting, and not detrimental to full contact bond of waterproofing materials.

D. Verify items penetrating surfaces to receive waterproofing are securely installed.

E. Verify substrate surface slopes to drain for horizontal waterproofing applications.

3.2 PREPARATION

A. Protect adjacent surfaces not designated to receive waterproofing.

B. Clean and prepare surfaces to receive waterproofing.

C. Do not apply waterproofing to surfaces unacceptable to manufacturer.

D. Seal cracks and joints with sealant materials using depth to width ratio as recommended by sealant manufacturer and/or in accordance with Section 07900.

3.3 INSTALLATION

A. Apply surface conditioner at rate recommended by manufacturer. Protect conditioner from rain or frost until dry.

B. Apply 300 mm wide strip of joint cover sheet over cracks, non-working joints, and expansion joints over 1.6 mm but not exceeding 13 mm in width.

C. At expansion joints from 13 to 25 mm in width, loop cover sheet down into joint between 31 and 44 mm. Extend sheet 150 mm on both sides of expansion joint.

D. Center cover sheet over crack or joints. Roll sheet into 3.2 mm coating of waterproofing material. Apply second coat over sheet extending minimum of 150 mm beyond sheet edges. Apply this procedure especially to expansion joints between horizontal and vertical surfaces.

E. Apply waterproofing material.

F. Apply and spread waterproofing material to a minimum cured thickness and averaging thickness as recommended by the manufacturer.

G. Extend membrane over cants and up intersecting surfaces at membrane perimeter minimum 150 mm above horizontal surface.

H. Install cant strips at inside corners.

I. Apply extra thickness of waterproofing material at corners, intersections, angles, and over joints.

J. Seal items protruding to or penetrating through membrane and install counter-flashing membrane material.

K. Extend waterproofing material and flexible flashing into drain clamp flange and apply adequate coating of liquid membrane to assure clamp ring seal. Coordinate with drain installation specified in Division 15 - Mechanical.

L. Install membrane flashings and seal into waterproofing material.

M. Conform to NRCA - Waterproofing Manual drawing details as noted:

N. Place drainage panel directly against membrane, butt joints, place to encourage drainage downward.

O. Place protection board and/or panel directly against drainage panel and/or membrane; butt joints.

P. Adhere protection board and/or drainage panel to substrate with mastic. Scribe and cut boards around projections, penetrations, and interruptions.

Q. Install Work in accordance with the drawings, to the manufacturer’s instructions and to the approval of the Engineer.

3.4 FIELD QUALITY CONTROL

A. General Requirements: Quality requirements for testing and inspection services, and execution requirements for testing, adjusting and balancing.

B. On completion of membrane installation, dam installation area as directed by the Engineer, in preparation for flood testing.

C. Flood to minimum depth of 25 mm with clean water. After 48 hours, verify no leaks with the Engineer.

D. When leaking is found, remove water, patch leaking areas with new waterproofing materials as directed by the Engineer; repeat flood test. Repair damage to building.

E. When area is proven watertight, drain water and remove dam.

3.5 PROTECTION OF INSTALLED CONSTRUCTION

A. General Requirements: Execution requirements for protecting installed construction.

B. Do not permit traffic over unprotected or uncovered membrane.

C. After membrane has cooled and/or cured, but before it becomes dusty, apply separation sheet. Lap joints to ensure complete coverage.

3.6 SCHEDULES

A. As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 07212

BOARD INSULATION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes rigid and semi-rigid board insulation and integral vapor retarder at cavity wall construction, perimeter foundation wall, underside of floor slabs, exterior walls, etc.

B. Related Sections:
1. Section 07260 - Vapor Retarders: Vapor retarder materials to adjacent insulation.
2. Section 07270 - Air Barriers: Air seal materials to adjacent insulation.

1.2 REFERENCES

A. ASTM International:
1. ASTM C240 - Standard Test Methods of Testing Cellular Glass Insulation Block.
2. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation.
3. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
4. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
5. ASTM C1289 - Standard Specification for Faced Rigid Cellular Thermal Insulation Board.
6. ASTM D2842 - Standard Test Method for Water Absorption of Rigid Cellular Plastics.
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.

B. National Fire Protection Association:
1. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.

C. Underwriters Laboratories Inc.:
1. UL 723 - Tests for Surface Burning Characteristics of Building Materials.

1.3 SYSTEM DESCRIPTION

A. Materials of this Section:
1. Provide continuity of thermal barrier at building enclosure elements.
2. Provide thermal protection to vapor retarder in conjunction with vapor retarder materials in Section 07260.
3. Provide thermal protection to air seal materials at building enclosure elements in conjunction with air barrier materials in Section 07270.

1.4 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

B. Product Data: Submit data on product characteristics, performance criteria, limitations, and adhesives.

C. Manufacturer's Installation Instructions: Submit special environmental conditions required for installation techniques.

D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 ENVIRONMENTAL REQUIREMENTS

A. General Requirements: Product requirements.

B. Do not install adhesives when temperature or weather conditions are detrimental.

1.6 SEQUENCING

A. Sequence Work to ensure fireproofing, firestopping, vapor retarder, and air barrier materials are in place before beginning Work of this section.

1.7 COORDINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Coordinate Work with Section 07260 and Section 07270.

PART 2 PRODUCTS

2.1 BOARD INSULATION

A. Manufacturer: Any internationally recognized manufacturer having an official technical agreement to conformity with standards for the product.

2.2 COMPONENTS

A. Polypropylene Protection Board: Two spaced layers, joined together with ribs:
1. 1.5 mm thick; Unit weight: 250g/m².
2. 5 mm thick; Unit weight: 650g/m².

B. Extruded Polystyrene Insulation Board: ASTM C578, type VII, cellular type:
1. Board Density: 35 kg/m³.
2. Board Size and Thickness: 1200 mm x 2400 mm x 50 mm thick.
3. Thermal Resistance: RSI of 0.87.
4. Water Absorption: To ASTM D2842, 0.3 percent by volume maximum.
5. Compressive Strength: Minimum 175 kPa.
6. Board Edges: Square, shiplap, or tongue and groove edges.
7. Flame/Smoke Properties: In accordance with ASTM E84.

2.3 ACCESSORIES

A. Adhesive Type 1: Type recommended by insulation manufacturer for application.

B. Adhesive Type 2: Vapor retarder type, trowel consistency; fire retardant compatible with insulation and substrate, as recommended by the manufacturer.

C. Sheet Vapor Retarder: Specified in Section 07260.

D. Tape: Bright aluminum, Polyethylene and/or Polyester self-adhering type, mesh reinforced, 50 mm wide.

E. Insulation Fasteners: Impaling clip as recommended by the manufacturer to be adhered and/or mechanically fastened to surface to receive board insulation, length to suit insulation thickness and substrate, capable of securely and rigidly fastening insulation in place.

F. Protective Boards: As recommended by the manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Verify substrate, adjacent materials, and insulation boards are dry and ready to receive insulation and adhesive.

C. Verify substrate surface is flat, free of honeycomb, fins, irregularities, and materials or substances affecting adhesive bond.

3.2 INSTALLATION

A. Install Work in accordance with the drawings, to the manufacturer’s instructions and to the satisfaction of the Engineer.

3.3 PROTECTION OF INSTALLED CONSTRUCTION

A. General Requirements: Execution requirements for protecting installed construction.

B. Do not permit damage to insulation prior to covering.

3.4 SCHEDULES

A. As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 07260

VAPOR RETARDERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes sheet and sealant materials for controlling vapor diffusion.

B. Related Sections:
1. Section 07270 - Air Barriers.

1.2 REFERENCES

A. ASTM International:
1. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
2. ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.

B. Sealant, Waterproofing and Restoration Institute:
1. SWRI - Sealant Specification.

1.3 PERFORMANCE REQUIREMENTS

A. Maximum Vapor Permeability (Perm): 1 ng/S/m/Pa measured in accordance with ASTM E96 Method E.

1.4 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

B. Product Data: Submit data indicating material characteristics, performance criteria, and limitations.

C. Manufacturer's Installation Instructions: Submit preparation and installation requirements, techniques.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with SWRI - Sealant and Caulking Guide Specification requirements for materials and installation.

1.6 MOCKUP

A. General Requirements: Quality requirements for mockup.

B. Construct mock-up, size as directed by the Engineer, of exterior wall, ceiling and attic vapor retarder including vapor retarder installation at typical window, door and wall ceiling intersection.

C. Locate where directed by the Engineer.

D. Remove mockup when directed by the Engineer.

1.7 SEQUENCING

A. Sequence Work to permit installation of materials in conjunction with other retardant materials and seals, and air barrier assemblies specified in Section 07270.

B. Do not install vapor retarder until items penetrating vapor retarder are in place.

PART 2 PRODUCTS

2.1 VAPOR RETARDERS

A. Manufacturer: Any internationally recognized manufacturer having an official technical agreement to conformity with standards for the product.

2.2 COMPONENTS

A. Sheet Retarder: Polyethylene film for above grade application, minimum 0.25 mm thick.

B. Sealant: Type as recommended by the Engineer

C. Primer and Backer Rods: As recommended by sealant manufacturer to suit application.

D. Cleaner: Non-corrosive type; as recommended by sealant manufacturer; compatible with adjacent materials.

E. Mastic Adhesive: asphalt type, compatible with sheet retarder and substrate, as recommended by manufacturer.

F. Adhesive: Compatible with sheet retarder and substrate, permanently non-curing, as recommended by manufacturer.

2.3 ACCESSORIES

A. Thinner and Cleaner: As recommended by sheet material manufacturer.

B. Tape: Bright aluminum, Polyethylene and/or Polyester self-adhering type, mesh reinforced, 50 mm wide, compatible with sheet material.

C. Attachments: Stainless steel type 316 bars and anchors.

PART 3 EXECUTION

3.1 PREPARATION

A. Remove loose or foreign matter capable of impairing adhesion.

B. Clean and prime substrate surfaces to receive adhesive and sealants.

3.2 EXISTING WORK

A. Clean and repair existing construction to provide positive and continuous seal for vapor retarders.

3.3 INSTALLATION

A. Install Work in accordance with the drawings, to the manufacturer's instructions and to the approval of the Engineer.

3.4 SCHEDULES

A. As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 07270

AIR BARRIERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes air leakage criteria for primary air seal building enclosure materials and assemblies; materials and installation methods supplementing other and primary air seal materials and assemblies; and air seal materials to connect and seal openings, joints, and junctions between other air seal materials and assemblies.

B. Related Sections:
1. Section 07260 - Vapor Retarders: Vapor retarders.
2. Section 07900 - Joint Sealers: Sealant materials and installation techniques.

1.2 REFERENCES

A. American Society of Civil Engineers:
1. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.

B. ASTM International:
1. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
2. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
3. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences across the Specimen.
4. ASTM E330 - Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.

C. Sealant, Waterproofing and Restoration Institute:
1. SWRI - Sealant Specification.

1.3 DEFINITIONS

A. Air Barrier: Continuous network of materials and joints providing air tightness, with adequate strength and stiffness to not deflect excessively under air pressure differences, to which it will be subjected in service. It can be comprised of single material or combination of materials to achieve performance requirements.

1.4 DESIGN REQUIREMENTS

A. Perform design work in accordance with ASCE 7.

1.5 PERFORMANCE REQUIREMENTS

A. Static Test: Resist air leakage caused by static air pressure across exterior wall assemblies and other interruptions to integrity of building enclosure systems; in accordance with ASTM E283 and/or ASTM E330.

B. Dynamic Test: Resist air leakage caused by dynamic air pressure across exterior wall assemblies and other interruptions to integrity of wall and roof systems; in accordance with ASTM E283 and/or ASTM E330.

C. Provide continuity of air seal materials and assemblies in conjunction with materials described in Division 3, Division 7 and Division 8.

1.6 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

B. Shop Drawings: Indicate special joint conditions.

C. Design Data: Submit design calculations.

D. Product Data: Submit data on material characteristics, performance criteria and limitations.

E. Manufacturer's Installation Instructions: Submit preparation, installation requirements and techniques, product storage and handling criteria.

1.7 QUALITY ASSURANCE

A. Perform Work to SWRI - Sealant and Caulking Guide Specification requirements.

B. Maintain one copy of each document on site.

1.8 MOCKUP

A. General Requirements: Quality requirements for mockup.

B. Construct mock-up of air barrier system, which is comprised of variety of materials.

C. Construct typical exterior wall panel, size as directed by the Engineer, incorporating window frame and sill, insulation, building corner condition, junction with roof membrane air seal, and vapor retarder; illustrating materials interface and seals.

D. Locate where directed by the Engineer.

E. Remove mockup when directed by the Engineer.

1.9 PRE-INSTALLATION MEETINGS

A. General Requirements: Administrative requirements for pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.10 ENVIRONMENTAL REQUIREMENTS

A. General Requirements: Product requirements.

B. Maintain temperature and humidity recommended by materials manufacturers before, during and after installation.

1.11 SEQUENCING

A. Sequence Work to permit installation of materials in conjunction with related materials and seals.

1.12 COORDINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Coordinate the Work of this section with sections referencing this section.

PART 2 PRODUCTS

2.1 AIR BARRIERS

A. Manufacturer: Any internationally recognized manufacturer having an official technical agreement to conformity with standards for the product.

2.2 COMPONENTS

A. Sheet Seal: Type as recommended by the manufacturer.

B. Liquid Seal: Type as recommended by the manufacturer.

C. Sealant: Type as recommended by the manufacturer.

D. Polysulfide Sealant: Type as recommended by the manufacturer.

E. Polyurethane Sealant: Type as recommended by the manufacturer.

F. Silicone Sealant: Type as recommended by the manufacturer.

G. Primer: As recommended by the manufacturer.

H. Substrate Cleaner: Non-corrosive, type as recommended by sealant manufacturer, compatible with adjacent materials.

I. Mastic Adhesive: Compatible with sheet seal and substrate, as recommended by the manufacturer.

J. Adhesive: Type compatible with sheet seal and substrate, permanently non-curing; As recommended by the manufacturer.

2.3 ACCESSORIES

A. Thinner and Cleaner for Sheet: As recommended by sheet material manufacturer.

B. Tape: Bright aluminum, Polyethylene and/or Polyester self adhering type, mesh reinforced, 50 mm wide, compatible with sheet material.

C. Attachments: Stainless steel type 316 bars and anchors.

PART 3 EXECUTION

3.1 PREPARATION

A. Clean and prime substrate surfaces to receive adhesive and sealants.

3.2 INSTALLATION

A. Install Work in accordance with the drawings, to the manufacturer's instructions and to the approval of the Engineer.

3.3 PROTECTION OF INSTALLED CONSTRUCTION

A. General Requirements: Execution requirements for protecting installed construction.

B. Do not permit adjacent work to damage work of this section.

3.4 SCHEDULES

A. As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 07620

SHEET METAL FLASHING AND TRIM

PART 1 GENERAL

1.1 SUMMARY

A. Section includes flashings and counterflashings, sheet metal roofing and fabricated sheet metal items, as indicated in Schedule.
   1. Provide reglets and accessories, precast concrete splash pads, and/or sheet metal splash pans.

B. Related Sections:
   1. Section 03100 - Concrete Forms and Accessories: Placement of recessed flashing reglets and accessories.
   2. Section 04810 - Unit Masonry Assemblies: Thu-wall flashings in masonry.
   3. Section 07900 - Joint Sealers.
   4. Section 09900 - Paints and Coatings: Field painting.
   5. Division 15 - Mechanical: Hangers and Supports.

1.2 REFERENCES

A. American Architectural Manufacturers Association:
   1. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.
   2. AAMA 2603 - Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.
   3. AAMA 2604 - Voluntary specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.
   4. AAMA 2605 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.

B. ASTM International:
   1. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   2. ASTM A666 - Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
   3. ASTM A924/A924M - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
   4. ASTM B32 - Standard Specification for Solder Metal.
   5. ASTM B101 - Standard Specification for Lead-Coated Copper Sheet and Strip for Building Construction.
   6. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
   7. ASTM B370 - Standard Specification for Copper Sheet and Strip for Building Construction.
   8. ASTM B749 - Standard Specification for Lead and Lead Alloy Strip, Sheet,

and Plate Products.

9. ASTM D226 - Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
10. ASTM D4397 - Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.
11. ASTM D4586 - Standard Specification for Asphalt Roof Cement, Asbestos-Free.

C. Copper Development Association Inc.:
1. CDA - Copper in Architecture - Handbook.

D. Federal Specification Unit:
1. FS TT-C-494 - Coating Compound, Bituminous, Solvent Type, Acid Resistant.

E. Sheet Metal and Air Conditioning Contractors:
1. SMACNA - Architectural Sheet Metal Manual.

1.3 DESIGN REQUIREMENTS

A. Sheet Metal Flashings: Conform to the criteria of SMACNA "Architectural Sheet Metal Manual" and/or Copper Development Association "Copper in Architecture - Handbook".

B. Gutter and Downspout Components: Conform to SMACNA Manual, CDA Handbook, SSINA Standard Practice, and/or NRCA Details for sizing components for rainfall intensity determined by storm occurrence of 1 in 5 years.

C. Maintain one copy of each document on site.

1.4 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

B. Shop Drawings: Indicate material profile, jointing pattern, jointing details, fastening methods, flashings, terminations, and installation details.

C. Product Data: Submit data on manufactured components metal types, finishes, and characteristics.

D. Samples:
1. Submit two samples, size as directed by the Engineer, illustrating seam, external and/or internal corners, valley, ridge, junction to vertical dissimilar surface, material and finish.

1.5 QUALIFICATIONS

A. Fabricator and Installer: Company specializing in sheet metal work with minimum ten years documented experience.

1.6 PRE-INSTALLATION MEETINGS

A. General Requirements: Administrative requirements for pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE AND HANDLING

A. General Requirements: Product requirements for product storage and handling.

B. Stack material to prevent twisting, bending, and abrasion, and to provide ventilation. Slope metal sheets to ensure drainage.

C. Prevent contact with materials causing discoloration or staining.

1.8 COORDINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Coordinate with Work of Section 03100 and Section 04810 for installing recessed flashing reglets.

PART 2 PRODUCTS

2.1 SHEET METAL FLASHING AND TRIM

A. Manufacturer: Any internationally recognized manufacturer having an official technical agreement to conformity with standards for the product.

B. Aluminum Sheet: ASTM B209M, alloy and temper as required for application and finish; 0.8 mm thick; finish and color as selected by the Engineer.

2.2 ACCESSORIES

A. Fasteners: Same material and finish as flashing metal.

B. Underlayment: ASTM D4397, 0.25 mm polyethylene.

C. Slip Sheet: As recommended by manufacturer.

D. Primer: As recommended by manufacturer.

E. Protective Backing Paint: As recommended by manufacturer.

F. Sealant: Type as specified in Section 07900.

G. Plastic Cement: ASTM D4586, Type I.

H. Reglets: As recommended by manufacturer.

I. Splash Pads: Precast concrete type, of sizes and profiles as indicated; minimum 29 MPa at 28 days, with minimum 5 percent air entrainment.

J. Downspout Boots and/or Shoes: As recommended by manufacturer.

K. Solder: ASTM B32; type suitable for application and material being soldered.

2.3 FABRICATION

A. Form sections shape indicated on Drawings, accurate in size, square and free from distortion or defects.

B. Fabricate cleats of same material as sheet metal, interlocking with sheet.

C. Form pieces in single length sheets.

D. Hem exposed edges on underside 13 mm; miter and seam corners.

E. Form material with standing, batten and/or flat lock seams, except where otherwise indicated. At moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.

F. Tin edges of copper sheet to be soldered. Solder shop formed metal joints. After soldering, remove flux. Wipe and wash solder joints clean. Weather seal joints.

G. Fabricate corners from one piece with minimum 450 mm long legs; seam and/or solder for rigidity, seal with sealant.

H. Fabricate vertical faces with bottom edge formed outward 6 mm and hemmed to form drip.

I. Fabricate flashings to allow toe to extend 50 mm over roofing gravel and/or paver. Return and brake edges.

J. Fabricate guards as detailed on drawings.

K. Fabricate gutters to profile and size indicated.

L. Fabricate downspouts to profile and size indicated.

M. Fabricate accessories in profile and size to suit gutters and downspouts.
1. Anchorage Devices: Type recommended by fabricator.
2. Gutter Supports: Type recommended by fabricator.
3. Downspout Supports: Type recommended by fabricator.

N. Fabricate splash pans of same metal type as downspouts, dimension as recommended by fabricator.

O. Seal metal joints.

2.4 FACTORY FINISHING

A. Factory Finish: as recommended by finish system manufacturer.

B. Primer Coat: Finish concealed side of metal sheets with primer compatible with finish system, as recommended by finish system manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Verify roof openings, curbs, pipes, sleeves, ducts, and vents through roof are solidly set, reglets in place, and nailing strips located.

C. Verify roofing termination and base flashings are in place, sealed, and secure.

3.2 PREPARATION

A. Install starter and edge strips, and cleats before starting installation.

B. Install surface mounted reglets to lines and levels indicated on Drawings. Seal top of reglets with sealant.

C. Paint concealed metal surfaces with protective backing paint to minimum dry film thickness of 0.4 mm.

3.3 INSTALLATION

A. Install work in accordance with the drawings, to the manufacturer’s recommendations and to the approval of the Engineer.

3.4 FIELD QUALITY CONTROL

A. General Requirements: Quality requirements for testing and inspection services, and execution requirements for testing, adjusting and balancing.

B. Inspection will involve surveillance of Work during installation to ascertain compliance with specified requirements.

3.5 SCHEDULES

A. As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 07900

JOINT SEALERS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes sealants and joint backing, precompressed foam sealers, hollow gaskets and accessories.

B. Related Sections:
1. Section 07260 - Vapor Retarders: Sealants required in conjunction therewith.
2. Section 07270 - Air Barriers: Sealants required in conjunction therewith.
3. Section 08800 - Glazing: Glazing sealants and accessories.
4. Section 09260 - Gypsum Board Assemblies: Acoustic sealant.
5. Section 09300 - Tile: Sealant used as tile grout.

1.2 REFERENCES

A. ASTM International:
1. ASTM C834 - Standard Specification for Latex Sealants.
2. ASTM C919 - Standard Practice for Use of Sealants in Acoustical Applications.
3. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
4. ASTM C1193 - Standard Guide for Use of Joint Sealants.
5. ASTM D1056 - Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
6. ASTM D1667 - Standard Specification for Flexible Cellular Materials - Vinyl Chloride Polymers and Copolymers (Closed-Cell Foam).
7. ASTM D2628 - Standard Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements.

1.3 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

B. Products Data: Submit data indicating sealant chemical characteristics, performance criteria, substrate preparation, limitations, and color availability.

C. Samples: Submit samples illustrating sealant colors for selection.

D. Manufacturer's Installation Instructions: Submit special procedures, surface preparation, and perimeter conditions requiring special attention.

E. Warranty: Include coverage for installed sealants and accessories failing to achieve airtight seal or watertight seal, exhibit loss of adhesion or cohesion, and sealants which do not cure.

1.4 QUALITY ASSURANCE

A. General Joint Sealer Performance Requirements: Select materials for compatibility with joint surfaces and other indicated exposures.
   1. Select modulus of elasticity and hardness or grade recommended by manufacturer for each application indicated.
   2. Where exposed to foot traffic, select materials of sufficient strength and hardness to withstand stiletto heel traffic without damage or deterioration of sealer system.

B. Color Selection: Provide colors indicated and if not, to match adjacent material or paint color; provide custom colors where required; colors to be selected by Engineer.

C. Perform work in accordance with sealant manufacturers' requirements for preparation of surfaces and material installation instructions.

D. Contractor shall require sealant manufacturer to review joint conditions and details, and shall submit to the Engineer written certification from the sealant manufacturer that joints are of the proper size and design, that the materials and backing will properly perform to provide permanent watertight, airtight or vaportight seals (as applicable), and that materials supplied meet specified performance requirements.
   1. Certification shall include copies of manufacturer's test regarding adhesion and staining of adjacent.

E. Perform acoustical sealant application work in accordance with ASTM C919.

F. Maintain one copy of each referenced document on site.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum ten years documented experience.

B. Applicator: Company specializing in performing Work of this section with minimum five years documented experience.

1.6 MOCKUP

A. General Requirements: Quality requirements for mockup.

B. Construct mockup of sealant joints in conjunction with window, wall and other mockups specified in other sections.

C. Construct mockup with specified sealant types and with other components noted.
   1. Determine preparation and priming requirements based on manufacturer's recommendations; take action necessary for correction of failure of sealant tests on mock-up.
   2. Verify sealants, primers and other components don't stain adjacent materials.

D. Locate where directed by the Engineer.

E. Remove mockup when directed by the Engineer.

1.7 ENVIRONMENTAL REQUIREMENTS

A. General Requirements: Products requirements.

B. Maintain temperature and humidity recommended by sealant manufacturer during and after installation.

1.8 COORDINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Coordinate Work with sections referencing this section.

PART 2 PRODUCTS

2.1 JOINT SEALERS

A. Manufacturer: Any internationally recognized manufacturer having an official technical agreement to conformity with standards for the product.

B. General:
1. Provide a complete system of cleaners, primers, fillers, tapes, backer rods and tapes and sealants in accordance with the manufacturer's requirements and the standards specified herein.
2. Color of Sealants:
a. For Concealed Joints: Provide the manufacturer's standard color which has the best overall performance quantities for the application shown.
b. For Exposed Joints: Provide custom colors as selected by the Engineer from the manufacturer's standard colors or other special custom colors.

C. 1-Part Polyurethane Sealants: Polyurethane based 1-part elastomeric sealant, in accordance and complying with Fed. Spec. TT-S-00230C, Type II Class A, with elongation and compression of not less than 25 %; ASTM C920, Type S, Class 25, Grade NS.
1. Location: Interior joints subject to movement.
2. Acceptable Manufacturers and Product:
a. Sika Chemical Corporation: Sikaflex-1a.
b. Sonneborn Building Products: Sonolastic NP-1.
c. Tremco: Dymonic.

D. 2-Part Polyurethane Sealant: Polyurethane based 2-part elastomeric sealant in accordance and complying with Fed. Spec. TT-S-00227, Type II, Class A, with elongation and compression of not less than 25 %; ASTM C920, Type M, Class 25, Grade NS.
1. Location: Exterior joints within masonry and concrete.
2. Acceptable Manufacturers and Product:
a. Tremco: Dymeric.
b. Sonneborn Building Products: Sonolastic NP II.

E. 2-Part Polyurethane Sealant for Horizontal Applications: Self leveling polyurethane based 2-part elastomeric sealant, complying with Fed. Spec. TT-S-00227E, Type I, Class A, with shore A hardness of not less than 30 and elongation and compression of not less than 25 %; ASTM C920, Type M, Class 25, Grade P.
   1. Location: Joints subject to pedestrian or vehicle traffic.
   2. Acceptable Manufacturers and Product:
      a. Tremco: THC900
      b. Sonneborn Building Products: Sonolastic Paving Joint Sealant.

F. Medium Modulus Silicone Rubber Sealant: Silicone rubber based 1-part neutral cure elastomeric sealant with plus 50 percent to minus 50 percent movement complying with ASTM C920 and Fed. Spec. TT-S-001543, Class A, and recommended by manufacturer for joints.
   1. Location: Exterior joints subject to movement, NOT in contact with external insulation finishing system (EIFS).
   2. Acceptable Manufacturers and Product:
      a. Dow Corning Corporation: 795 Building Sealant or DC 791.
      b. Sonneborn, ChemRex Inc.: Sonolastic Omniseal or OmniPlus.
      c. Tremco Construction Division: Spectrum 2.

G. Medium Modulus Silicone Rubber Sealant to Reduce Bleeding and Mildew Growth: Silicone rubber based 1-part neutral cure elastomeric sealant with plus 50 percent to minus 50 percent movement specially designed for exterior application to reduce bleeding and mildew growth complying with ASTM C920.
   1. Location: Exterior joints in metal panels and exterior ceramic tile.
   2. Acceptable Manufacturers and Product:
      a. Dow Corning Corporation: 756 Building Sealant - HP.

H. Ultra Low-Modulus Silicone Rubber Sealant: Silicone rubber based 1-part neutral cure elastomeric sealant with plus 100 percent to minus 50 percent movement complying with ASTM C920 and Fed. Spec. TT-S-001543, Class A.
   1. Location: Joints in contact with external insulation finishing system (EIFS).
   2. Acceptable Manufacturers and Product:
      a. Dow Corning Corporation: 790 Building Sealant, or DC 791 for nonfire rated, and FS 700 for fire rated.

I. High Modulus Silicone Rubber Sealant: 1-part nonacid-curing silicone.
   1. Location: Joints related to structural glazing.
   2. Acceptable Manufacturers and Product:
      a. Dow Corning Corporation: Silicone 799, or DC 895.
      b. General Electric: Ultraglaze SSG 4000.

J. Mildew-Resistant Silicone Rubber Sealant: Silicone rubber based 1-part mildew resistance sealant with integral fungicide complying with Fed. Spec. TT-S-001543, Class A. Specifically recommended by manufacturer for interior joints in wet areas around plumbing fixtures and ceramic tile.
   1. Location: Joints in ceramic tile walls and floors, around equipment, and around plumbing fixtures.
   2. Acceptable Manufacturers and Product:
      a. General Electric: Sanitary 1700 Sealant.

b. Dow Corning Corporation: Silicone 786 mildew resistant, or DC 798.

K. Acrylic Sealants: General purpose, paintable acrylic-emulsion sealant with plus 7.5 percent to minus 7.5 percent movement complying with ASTM C834.
1. Location: Interior joints NOT subject to movement.
2. Acceptable Manufacturers and Product:
a. Tremco: Acrylic Latex 834.
b. Sonneborn Building Products: Sonolac.
c. Dow Corning Corporation: FS 400.

L. 2-Part Polysulfide Sealant: Polysulfide based 2-part elastomeric sealant with plus 25 percent to minus 25 percent movement, complying with Fed. Spec. TT-S-00227, type II, class A, non-sag synthetic rubber formulated form “Thiokol LP” polymer and recommended by manufacturer for continuous submersion in chlorinated water.
1. Location: Joints submerged in water.
2. Acceptable Manufacturers and Product:
a. Pecora Corporation: Synthacalk GC-5.
b. Sonneborn Building Products.

M. Foam Gasket Seal: Precompressed, impregnated open-cell foam sealant incorporating permanently elastic open cell polyurethane foam, manufacturer’s standard impregnating agent, and pressure sensitive backing.
1. Acceptable Manufacturers and Product:
a. Emseal Corporation: Emseal Greyflex.
b. Illbruck Inc.: Will-Seal 150.
c. York Manufacturing, Inc.: York-Seal 100.

N. Foam Gasket Seal for Submerged Application: Precompressed, impregnated opencell foam sealant incorporating permanently elastic open cell polyurethane foam, manufacturer’s impregnating agent at higher levels than standard product, and pressure sensitive backing.
1. Specially designed for use in submerge application.
2. Acceptable Manufacturers and Product:
a. Emseal Corporation: Emseal.
b. Illbruck Inc.: Will-Seal 200.
c. York Manufacturing, Inc.: York-Seal 200.

O. Splice Adhesive for Foam Gasket Seal: 1-part urethane wet sealant as recommended by gasket seal manufacturer.

2.2 ACCESSORIES

A. Primer: Non-staining type, recommended by sealant manufacturer to suit application.

B. Joint Cleaner: Non-corrosive and non-staining type, recommended by sealant manufacturer; compatible with joint forming materials.

C. Joint Backing: Round foam rod compatible with sealant; ASTM D1056, sponge or expanded rubber; or ASTM D1667, closed cell PVC; oversized 30 to 50 % larger than joint width.
1. Type: As recommended by manufacturer.

D. Bond Breaker: Pressure sensitive tape recommended by sealant manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Verify substrate surfaces and joint openings are ready to receive work.

C. Verify joint backing and release tapes are compatible with sealant.

3.2 PREPARATION

A. Remove loose materials and foreign matter impairing adhesion of sealant.

B. Clean and prime joints.

C. Perform preparation in accordance with ASTM C1193.

D. Protect elements surrounding Work of this section from damage or disfiguration.

3.3 INSTALLATION

A. Perform installation in accordance with ASTM C1193.

B. Perform acoustical sealant application work in accordance with ASTM C919.

C. Measure joint dimensions and size joint backers to achieve width-to-depth ratio, neck dimension, and surface bond area as recommended by manufacturer, except where specific dimensions are indicated.

D. Install bond breaker where joint backing is not used.

E. Install sealant free of air pockets, foreign embedded matter, ridges, and sags.

F. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

G. Tool joints as detailed.

H. Precompressed Foam Sealant: Do not stretch; avoid joints except at corners, ends, and intersections; install with face 3 to 6 mm below adjoining surface.

I. Compression Gaskets: Avoid joints except at ends, corners, and intersections; seal joints with adhesive; install with face 3 to 6 mm below adjoining surface.

3.4 CLEANING

A. General Requirements: Execution requirements for final cleaning.

B. Clean adjacent soiled surfaces.

3.5 PROTECTION OF INSTALLED CONSTRUCTION

A. General Requirements: Execution requirements for protecting installed construction.

B. Protect sealants until cured.

3.6 SCHEDULES

A. As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 08114

STANDARD STEEL DOORS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes non-rated and fire rated steel doors, panels and door louvers.

B. Related Sections:
1. Section 08115 - Standard Steel Frames.
2. Section 08710 - Door Hardware.
3. Section 08800 - Glazing: Glass for doors.
4. Section 09900 - Paints and Coatings: Field painting of doors.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI A250.8 - Recommended Specifications for Standard Steel Doors and Frames.

B. ASTM International:
1. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
2. ASTM C1363 - Standard Test Method for the Thermal Performance of Building Assemblies by Means of a Hot Box Apparatus.
3. ASTM E413 - Standard Classification for Rating Sound Insulation.

C. Hollow Metal Manufacturers Association:
1. HMMA 810 - Hollow Metal Doors.

D. National Fire Protection Association:
1. NFPA 80 - Standard for Fire Doors, Fire Windows.
2. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.

E. Steel Door Institute:
1. SDI 108 - Recommended Selection and Usage Guide for Standard Steel Doors.

F. Underwriters Laboratories Inc.:
1. UL 10B - Fire Tests of Door Assemblies.

G. Uniform Building Code:
1. UBC Standard 7-2 - Fire Tests of Door Assemblies.

1.3 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

B. Shop Drawings: Indicate door elevations, internal reinforcement, closure method, and cut-outs for glazing, louvers, and finishes.

C. Product Data: Submit door configurations, location of cut-outs for hardware reinforcement.

D. Samples: Submit two samples of door face metal, 450 x 450 mm in size illustrating shop finish colors and surface texture.

E. Manufacturer's Installation Instructions: Submit special installation instructions.

F. Manufacturer's Certificate: Certify that Products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with the drawings, to the manufacturer’s instructions and to the approval of the Engineer.

B. Perform Work in accordance with ANSI A250.8.

C. Fire Rated Door and Panel Construction: Conform to NFPA 252, UL 10B and/or UBC Standard 7-2.

D. Fire Rated Door Construction: Rate of rise of 361 ºC across door thickness for stairs.

E. Installed Door and Panel Assembly: Conform to NFPA 80 for fire rated class as indicated on Drawings.

F. Maintain one copy of each document on site.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum ten years documented experience.

B. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. General Requirements: Product requirements for transporting, handling, storing, and protecting products.

B. Accept doors on site in manufacturer's packaging. Inspect for damage.

C. Break seal on site to permit ventilation.

1.7 COORDINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Coordinate Work with door opening construction, door frame, and door hardware

installation.

C. Coordinate installation to accommodate door hardware electric wire connections.

PART 2 PRODUCTS

2.1 STANDARD STEEL DOORS

A. Manufacturer: Any internationally recognized manufacturer having an official technical agreement to conformity with standards for the product.

B. Steel Door: To SDI standard, extra heavy duty, reinforced steel door where indicated, full flush door with foamed-in-place polyurethane core insulation.
   1. Fabricate with watertight metal top channel and construct to receive weatherstripping indicated.
   2. Material and Finish: Cold-rolled sheet steel with shop primer for field finishing under Section 09900.
   3. Thickness: 50 mm approximately.
   4. Face Sheet: 2.0 mm thick each.
   5. Fire Rating: 120 or 60 minutes, or non-fire rated, as shown on drawings or as directed by the Engineer.

C. Astragals: Provide full length steel astragal for pairs, attached to secure side of opening, projecting not less than 20mm, unless hardware specified allows both doors, swinging in same direction, to be active.

D. Wire Chases: Fabricate wireways within doors or transom panels for installation and connection of electrical devices.

E. Glazing Stops: Flush type steel with removable stops on 1 side of glass. Install fixed stops on locked side of interior doors and outside of exterior doors. Fabricate to accommodate glass thickness as detailed.

F. Minimum Door Reinforcement: Use 16 gauge spot welded plates for surface items and those not otherwise specified. Gauges specified are minimum.
   1. Hinges: Not less than 7 gauge, 32mm by 250mm with at least 3 electric spot welds staggered at each end.
   2. Floor Hinges and Pivots: Not less than 7 gauge, size per manufacturer’s template recommendation.
   3. Mortise Lock: Not less than 12 gauge with centering clips for lock case alignment and 14 gauge reinforcement for escutcheons or roses.
   4. Cylindrical Lock: Not less than 12 gauge for lock front and 2 welded-in support clips.
   5. Flush Bolts: Not less than 12 gauge, size per manufacturer’s template recommendation.
   6. Exit Devices: Not less than 14 gauge, size per manufacturer’s template recommendation.
   7. Surface Door Closer: Not less than 12 gauge channel type reinforcement not less than 100mm high by 450mm long with not less than 8 electric spot welds for application of door closers at any time on all doors.

8. Mortise Door Closer: Not less than 14 gauge channel type reinforcement per manufacturer's template recommendation.
9. Overhead Holders and Stops: Not less than 12 gauge channel type reinforcement per manufacturer's template recommendation. Mortise type reinforcing channel to receive holder in a snug fit.
10. Pulls and Pull Bars: Not less than 16 gauge plate type reinforcement for concealed fastening and 12 gauge channel type for through-bolt mounting.

G. Fire Rated Doors: All fire rated doors shall, in addition to what is stated above, comply with ANSI A250.8, and/or SDI 108.

2.2 COMPONENTS

A. Face: Steel sheet in accordance with ANSI A250 and/or SDI 108.

B. End Closure: Channel, 1.2 mm thick, flush and/or inverted.

C. Core: Cardboard honeycomb, polyurethane, polystyrene foam, mineral fiberboard, steel channel grid and/or vertical steel stiffeners.

D. Thermal Insulated Door: Total insulation RSI value measured in accordance with ASTM C1363.

E. Sound Rated Door: STC measured in accordance with ASTM E413.

2.3 ACCESSORIES

A. Louvers:
1. Material and Finish: Roll formed; prime painted, color as selected.
2. Louver Blade: Inverted V, Y or slat blade; fire rated with fusible link design to UL or FM requirements.
3. Louver Free Area: As indicated on drawings.
4. Frame: As indicated on drawings.

B. Removable Stops: Rolled steel, channel shape, butted and/or mitered corners; prepared for countersink style tamper proof screws.

C. Astragals for Double Doors: Steel or aluminum, Z or T shaped.

D. Primer: ANSI A250.10 rust inhibitive type.

2.4 FABRICATION

A. Fabricate doors with hardware reinforcement welded in place.

B. Attach astragal to one leaf of pairs of doors.

C. Attach fire rating label to each fire rated door. Indicate temperature rise rating for stair doors.

D. Configure exterior doors with edge profile to receive recessed weatherstripping.

2.5 SHOP FINISHING

A. Steel Sheet: Galvanized to ASTM A653/A653M Z120, Z180 and/or Z275.

B. Primer: Air dried or baked.

C. Shop Finish: Baked enamel or thermosetting epoxy of color as selected.

PART 3 EXECUTION

3.1 EXAMINATION

A. General Requirements: Administrative requirements for verification of existing conditions before starting work.

B. Verify opening sizes and tolerances are acceptable.

3.2 DOORS AND HARDWARE INSTALLATION

A. Install doors in accordance with ANSI A250.8.

B. Coordinate installation of glass and glazing specified in Section 08800.

C. Coordinate installation of doors with installation of frames specified in Section 08115 and hardware specified in Section 08710.

D. Doors shall be fitted with the specified hardware, hung and immediately before final completion of work, additional adjustments shall be made so that doors operate in perfect order.

E. Location of hardware on doors and frames shall be in accordance with applicable standard of the National Association of Architectural Metal Manufacturers (NAAMM) and the Door Hardware Institute (DHI).

F. Hardware shall be assorted and stored in space assigned and shall be kept under lock and key. The safety and preservation of delivered items will be the responsibility of the Contractor.

G. Doors shall be installed with the following clearances unless otherwise indicated on the drawings:
   1. Jambs: 3.75 mm each side; 7.5mm total.
   2. Head: 3.75 mm.
   3. Meeting edges, pairs of doors: 3.75 mm.
   4. Bottom: 9.5 mm, where no threshold or carpet occurs.
   5. Bottom: At threshold or carpet, 3.75mm above carpet or threshold.
   6. Place fire-rated doors with clearances as specified in NFPA No. 80 Standard.

H. Install finishing hardware in accordance with manufacturer’s written instructions. Do not modify finishing hardware. Set, fit, adjust and clean hardware according to

manufacturer's written instruction. After installation of hardware under this section, check opening units for correct fit and uniformity of space around perimeter of units, or between units. Ensure smoothly operating opening units free from binding.

I. After installation, templates, instruction sheets, and installation details, shall be turned over to the Owner's representative at the project closeout.

J. Do not use shims without Engineer's approval.

K. Wrapping or other factory-applied protection furnished with finish hardware, installed under this section, shall be left on such hardware, or, if removed, replaced on completion of hardware installation, until final acceptance of the building by the Engineer, at which time protection shall be removed and work left in proper condition.

L. Exposed surfaces shall be free of any tool marks, rust, or blemishes, and any damage to exposed surfaces shall be repaired or replaced at the Contractor's expense and to the satisfaction of the Engineer and Owner.

M. Fasteners furnished with the hardware shall be used to secure the hardware in place for each type of substrate. Through-bolts shall in no case be permitted for the fastening of any hardware unless otherwise approved. Hardware shall be properly adjusted and checked out to ensure the hinges, locks, latches, bolts, holders and closers are in proper operational condition. After hardware has been checked, key shall be tagged, identified and delivered to the Owner. Any errors in cutting and fitting, keying or any damage to adjoining work shall be repaired at no extra cost to the Owner or Engineer. Drill and countersink units which are not factory prepared for anchorage.

N. Cut and fit threshold and floor covers to profile of door frames, with mitered corners and hairline joints. Join units with concealed welds or concealed mechanical joints. Cut smooth openings for spindles, bolts and similar items, if any.

O. Keys used shall be construction keys which are to be tagged with fiber discs as approved, clearly labeled with identifying inscriptions and then neatly arranged in a temporary cabinet. Construction keys shall be returned to the Owner.

P. Adjusting and Cleaning: Adjust and check each operating item of hardware and each door, to ensure proper operation or function of every unit. Lubricate moving parts with type lubrication recommended by manufacturer. Replace units which cannot be adjusted and lubricated to operate freely and smoothly as intended for the application made. Final adjustment of hardware is to be done after heating and ventilating has been balanced.

Q. Rejection: Hollow metal work which in the opinion of the Engineer is defective, shall be removed and replaced with new at no additional cost. Rejection will additionally be considered for items including; hardware cutouts of improper size or location or which prevent proper installation of doors, hardware or work of other trades.

3.3 ERECTION TOLERANCES

A. General Requirements: Quality requirements for tolerances.

B. Maximum Diagonal Distortion: 1.5 mm measured with straight edge, corner to corner.

3.4 ADJUSTING

A. General Requirements: Execution requirements for adjusting.

B. Adjust door for smooth and balanced door movement.

3.5 SCHEDULES

A. As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 08115

STANDARD STEEL FRAMES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes fire rated and non-rated steel frames.
   1. Provide frames for interior and exterior glazed lights.

B. Related Sections:
   1. Section 03300 - Cast-In-Place Concrete: Placement of anchors into concrete wall construction.
   2. Section 04810 - Unit Masonry Assemblies: Masonry grout fill of metal frames and placement of anchors into masonry wall construction.
   3. Section 08114 - Standard Steel Doors.
   4. Section 08212 - Flush Wood Doors.
   5. Section 08710 - Door Hardware: Hardware, silencers and weatherstripping.
   6. Section 08800 - Glazing.
   7. Section 09900 - Paints and Coatings.

1.2 REFERENCES

A. American National Standards Institute:
   1. ANSI A250.8 - Recommended Specifications for Standard Steel Doors and Frames.

B. ASTM International:
   1. ASTM A591/A591M - Standard Specification for Steel Sheet, Electrolytic Zinc-Coated, for Light Coating Mass Applications.
   2. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

C. National Fire Protection Association:
   1. NFPA 80 - Standard for Fire Doors, Fire Windows.
   2. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.

D. Underwriters Laboratories Inc.:
   1. UL 10B - Fire Tests of Door Assemblies.

E. Uniform Building Code:
   1. UBC Standard 7-2 - Fire Tests of Door Assemblies.

1.3 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

B. Shop Drawings: Indicate frame elevations, reinforcement, anchor types and spacing, location of cut-outs for hardware, and finish.

C. Product Data: Submit frame configuration and finishes.

D. Samples: Submit two samples of frame, size as directed by the Engineer, illustrating factory finished frame colors and surface texture.

E. Manufacturer's Installation Instructions: Submit special installation instructions.

F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALITY ASSURANCE

A. Conform to requirements of ANSI A250.8.

B. Fire Rated Frame Construction: Conform to NFPA 252, UL 10B and/or UBC Standard 7-2.

C. Installed Frame Assembly: Conform to NFPA 80 for fire rated class same as door.

D. Maintain one copy of each document on site.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum ten years documented experience.

1.6 DELIVERY, STORAGE, AND HANDLING

A. General Requirements: Product requirements for product storage and handling.

B. Accept frames on site in manufacturer's packaging. Inspect for damage.

C. Break seal on-site to permit ventilation.

1.7 COORDINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Coordinate Work with frame opening construction, door, and hardware installation.

C. Sequence installation to accommodate required door hardware electric wire connections.

PART 2 PRODUCTS

2.1 MATERIALS

A. Sheet Steel: Commercial quality, cold rolled, picked, annealed and stretcher leveled, entirely free from scale, pitting, wave or other defects. Gauges indicated on drawings and specified for sheet steel refer to the US Standard Gauge for Sheet Iron and Steel.
1. Sheet Steel for Frames: ASTM A569 and ASTM A468, hot rolled prime

quality carbon steel.

2. Galvanized Steel: Treat with hot dip galvanizing (ASTM A 526) to ensure prime paint adhesion.
3. Electrolytically Galvanized Steel: Electrolytically deposited zinc coating on cold-rolled steel sheet.

B. Steel Shapes: Provide steel for supporting, reinforcing and attachment of work.
1. Structural Steel: ASTM A36.
2. Plates: ASTM A283, Grade C.

C. Sound-Deadening and Heat Retarding Filler: Mineral wool or other inorganic insulating noncombustible non-settling material, verminproof and complying with labeling requirements.

D. Accessories: Provide manufacturer's standard or custom units for supports, anchors, inserts and fasteners. Hot dip galvanized units to comply with ASTM A153, Class B.

E. Shop Primer: Baked-on shop primer compatible with respective specified finish paint and complying with ANSI A224.

F. Fasteners: Galvanized or cadmium plated steel.
1. Bolts and Nuts: ASTM A307, Grade A
2. Expansion Bolts: FS FF-S-325, Group III, expansion shield (self drilling tubular expansion shell bolt anchors), Type 1 or 2.
3. Machine Screws: FS SS-S-92, carbon steel, Type III cross-recessed, design I or II recess, style 2C flat head.
4. Use special bolts for fixing to aerated concrete.

G. Bituminous Paint: "Bitumastic 50" (Kop Coat, Inc.) or equal approved.

2.2 PRODUCTS

A. Manufacturer: Any internationally recognized manufacturer having an official technical agreement to conformity with standards for the product.

B. Frames to comply with ANSI A250.8 Grade and to suit model of door specified.

C. Fully Welded Frames: Fabricated with corners fully mitered including stop to hairline accuracy with face joints continuously welded from outside and ground smooth.
1. Weld entire seam (including seams between head and jamb rabbets, stops, and soffits) from backside, with a continuous weld bead. If weld penetration occurs, file smooth and finish joints flush and smooth to produce invisible connections.
2. Provide at exterior locations.

D. Welded Frames: Fabricated with mitered corners, not including stop, to hairline accuracy with face joints continuously welded from outside and ground smooth.
1. Weld seam (including seams between head and jamb face and soffits) from backside, with a continuous weld bead. If weld penetration occurs, file smooth and finish joints flush and smooth to produce invisible connections.
2. Stops: Tight butt joint.
3. Provide at locations, except as where indicated for fully welded frames.

E. Knocked Down Frame: Rigid interlock between header and jambs, with miter joint, for field assembly.

F. Drywall Slip-On Frame: Rigid interlock between header and jambs, with miter joint, for field assembly of frame in partition opening to lap over installed partition construction.

G. Light Gauge Slip-On Frame with Snap-On Trim: Field assembly of frame in partition opening to lap over installed partition construction, including snap-on trim.

2.3 HOLLOW METAL FRAMES

A. Floor anchors shall be 2.7 mm steel welded inside each jamb with 2 anchor holes; for 9.5 mm diameter fasteners.

B. Construct end closure of same gauge as frame.

C. Jamb Anchors:
   1. or Masonry Construction: Welded adjustable, 1.6mm steel jamb anchors, corrugated, with leg not less than 50mm wide by 250mm long. Furnish at least 3 anchors per jamb up to 2,290mm height; 4 anchors up to 2,400mm jamb height; one additional anchor for each 600mm or fraction thereof over 2440mm height.
   2. For Metal Stud Partitions: Furnish 1.6mm hat section anchors welded to back of frames. Furnish at least 3 anchors per jamb up to 2,290mm height, 4 anchors up to 2,400mm jamb height, one additional anchor for each 600mm or fraction thereof, over 2,400 mm height.

D. Head Anchors and Reinforcing
   1. For frames in steel stud walls, provide a minimum of 2 anchors at head of frames.
   2. For frames over 1,200mm wide in masonry walls, provide continuous steel channel or angle stiffener, not less than 2.7mm thickness, for fully width of openings welded to back of frame at head. Reinforcing is not to act as lintel or load carrying members.

E. Provide removable spreader bar across bottom of frames, tack welded to jambs and mullions. Remove spreaders after frames are enclosed and built into adjacent work.

F. Drill stop to receive silencers on doors frames. Install plugs to keep holes clear during construction.

G. Provide .7mm steel plaster guards or dustcover boxes, welded to frame, at back of finish hardware cutouts where mortar or other materials might obstruct hardware installation.

H. Head Reinforcement: Frame heads, unless otherwise indicated, shall be reinforced with bend plate channels of 3.5mm minimum, or heavier as required to sustain the imposed masonry loads. Return bends of frames shall be flanged as detailed.

2.4 REINFORCEMNT FOR HARDWARE

A. Mortise, reinforce, drill and tap hollow metal work for hardware devices at the factory from fully templated hardware, in accordance with approved hardware schedule including electric hardware devices and templates provided by the other trades supplying the hardware. Where surface mounted hardware is to be applied, hollow metal work shall have reinforcing only; drilling and tapping shall be done in the field by trade installing doors and finish hardware. Provide cutouts and reinforcing as required for security hardware and electrical work, including providing of related coverplates. Reinforcement shall be concealed.

B. Minimum thickness for hardware reinforcing shall be as follows:
   1. For butts and pivot hinges: 4.8 mm steel plate, 32 x 250 mm minimum size.
   2. For closers, overhead: 4.8mm steel plate, on holders and stops both sides of frame so closers, holders or stops can be applied to either side of frame.
   3. For strikes: 2.7 mm sheet steel.
   4. For lock face, latch face and flush bolts: 2.7mm sheet steel (interior doors) 30mm sheet steel (exterior doors). Lock and latch reinforcement at least 40mm by 80 mm.
   5. Dust cover boxes, mortar guards and electric devices (at hardware mortises on frames to be set in masonry or plaster): .7 mm sheet steel.
   6. For other surface-mounted hardware: 2.7mm gauge sheet steel.

2.5 ACCESSORIES

A. Removable Stops: Rolled steel and/or aluminum channel shape, butted and/or mitered corners; prepared for countersink style tamper proof screws.

B. Bituminous Coating: Non-asbestos fibered asphalt emulsion.

C. Primer: ANSI A250.10 rust inhibitive type.

D. Silencers: Specified in Section 08710.

E. Weatherstripping: Specified in Section 08710.

2.6 FABRICATION

A. Fabricate frames as welded unit.

B. Mullions for Double Doors: Fixed and/or Removable type, of same profiles as jambs.

C. Transom Bars for Glazed Lights: Fixed type, of same profiles as jamb and head.

D. Fabricate frames with hardware reinforcement plates welded in place. Provide mortar guard boxes.

E. Reinforce frames wider than 1 200 mm with roll formed steel channels fitted tightly into frame head, flush with top.

F. Terminate door stops 150 mm above finished floor. Cut stop at 45º or 90º angle and close.

G. Prepare frames for silencers. Provide three single silencers for single doors and mullions of double doors on strike side. Provide two single silencers on frame head at double doors without mullions.

H. Configure exterior frames with special profile to receive recessed weatherstripping.

I. Attach fire rated label to each fire rated frame.

J. Fabricate frames to suit masonry wall coursing with 100 and/or 50 mm head member.

2.7 SHOP FINISHING

A. Steel Sheet: Galvanized to ASTM A653/A653M Z120 Z180 and/or Z275.

B. Primer: Air dried and/or baked.

C. Factory Finish: Baked enamel and/or Thermosetting epoxy of color as selected.

D. Coat inside of frame profile with bituminous paint to minimum thickness of 1.5 mm.

PART 3 EXECUTION

3.1 EXAMINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Verify opening sizes and tolerances are acceptable.

3.2 INSTALLATION

A. Install frames in accordance with ANSI A250.8.

B. Coordinate with masonry, gypsum board and/or concrete wall construction for anchor placement.

C. Coordinate installation of glass and glazing specified in Section 08800.

D. Coordinate installation of frames with installation of hardware specified in Section 08710 and doors in Section 08114 and Section 08212.

E. Set hollow metal frames at locations shown, in perfect alignment and elevation, plumb, level, straight, true and free from rack. Brace frames to prevent displacement.

F. Extend frame anchorages below sills and finishes, except over membrane waterproofed areas. Anchor bottom of frames to floors with anchor bolts or with power driven fasteners. Coordinate the installation of built-in anchors for wall and

partition construction as required with other work.

G. After wall construction has been completed, remove temporary braces. Leave surfaces smooth and undamaged.

H. Apply hardware in accordance with hardware manufacturer's instructions and Section 08710 of these Specifications. Drill and tap for machine screws as required. Do not use self-tapping sheet metal screws.

I. Anchor panels in place with concealed fasteners. Adjust door installation to provide uniform clearance at head and jambs, and to contact stops uniformly. Remove and replace doors which are found to be warped, bowed or otherwise damaged and cannot be properly fitted in frames.

3.3 INSTALLATION METAL FRAMES

A. Install frames in accordance with approved shop drawings, manufacturer's recommendations and as specified herein.

B. Steel frames shall be set in the correct locations in perfect alignment, plumb, straight and true. Frames shall be substantially braced to prevent displacement until adjacent construction has been completed and anchors installed. Removable spreaders in frames shall not be removed until frame has been permanently anchored to floor and at jambs.

C. Provide masonry anchorage devices where required for securing hollow metal frames to in-place concrete or masonry construction.

D. Set anchorage devices opposite each anchor location, in accordance with details on final shop drawings and anchorage device manufacturer's instructions. Leave drilled holes rough, not reamed, and free from dust and debris.

E. At in-place concrete or masonry construction, set frames and secure in place with machine screws and masonry anchorage devices.

F. In masonry construction, building-in of anchors and grouting of frames is included in Section 04810.

G. In steel stud partitions, attach wall anchors to studs with tapping screws.

H. Place frames at fire-rated openings in accordance with NFPA Standard No. 80.

I. Make field splices in frames as detailed on final shop drawings, welded and finished to match factory work.

J. Remove spreader bards before installation of frames. Bucks shall be properly set and secured, plumb and level.

K. Install roll formed steel reinforcement channels between two abutting frames. Anchor to structure and floor.

3.4 ERECTION TOLERANCES

A. General Requirements: Quality requirements for tolerances.

B. Maximum Diagonal Distortion: 1.5 mm measured with straight edges, crossed corner to corner.

3.5 SCHEDULES

A. As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 08212

FLUSH WOOD DOORS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes flush wood doors and transom panels; flush and flush glazed configuration with louvers; fire rated and non-rated.

B. Related Sections:
1. Section 06200 - Finish Carpentry: Wood door frames.
2. Section 08114 - Standard Steel Doors: Metal louvers.
3. Section 08115 - Standard Steel Frames.
4. Section 08710 - Door Hardware.
5. Section 08800 - Glazing.
6. Section 09900 - Paints and Coatings: Site finishing of wood doors.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI A135.4 - Basic Hardboard.

B. ASTM International:
1. ASTM E413 - Standard Classification for Rating Sound Insulation.

C. Architectural Woodwork Institute:
1. AWI - Quality Standards Illustrated.

D. Hardwood Plywood and Veneer Association:
1. HPVA HP-1 - American National Standard for Hardwood and Decorative Plywood.

E. National Electrical Manufacturers Association:
1. NEMA LD 3 - High Pressure Decorative Laminates.

F. National Fire Protection Association:
1. NFPA 80 - Standard for Fire Doors, Fire Windows.
2. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.

G. Underwriters Laboratories Inc.:
1. UL 10B - Fire Tests of Door Assemblies.
2. UL - Building Materials Directory.

H. Uniform Building Code:
1. UBC Standard 7-2 - Fire Tests of Door Assemblies.

I. Intertek Testing Services (Warnock Hersey Listed):
1. WH - Certification Listings.

1.3 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

B. Shop Drawings: Illustrate door opening criteria, elevations, sizes, types, swings, undercuts required, special beveling, special blocking for hardware, factory machining criteria, and factory finishing criteria, identify cutouts for glazing and louvers.

C. Product Data: Submit information on door core materials and construction, and on veneer species, type and characteristics.

D. Samples:
1. Submit two samples of door construction, size as directed by the Engineer, cut from top and/or bottom corner of door.
2. Submit two samples of door veneer cut and grain pattern, size as directed by the Engineer, cut horizontally across the entire width of the door, showing veneer slices, match pattern and joint.
3. Submit two samples of door veneer, size as directed by the Engineer, illustrating wood grain, stain color, and sheen, and/or plastic laminate pattern and color.

E. Manufacturer's Installation Instructions: Submit special installation instructions.

1.4 QUALITY ASSURANCE

A. Perform Work in accordance with AWI Quality Standard Section 1300, Premium, Custom and/or Economy Grade.

B. Finish doors in accordance with AWI Quality Standard Section 1500.

C. Fire Door and Panel Construction: Conform to NFPA 252, UL 10B and/or UBC Standard 7-2.

D. Fire Rated Door Construction: Rate of rise of 361 ºC across door thickness for stair doors.

E. Installed Fire Rated Door and Transom Panel Assembly: Conform to NFPA 80 for fire rated class as indicated.

F. Maintain one copy of each document on site.

1.5 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum ten years documented experience.

B. Installer: Company specializing in performing work of this section with minimum five years documented experience.

1.6 DELIVERY, STORAGE AND HANDLING

A. General Requirements: Product requirements for product storage and handling.

B. Package, deliver and store doors in accordance with AWI Section 1300.

1.7 COORDINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Coordinate Work with door opening construction, door frame and door hardware installation.

1.8 WARRANTY

A. General Requirements: Execution requirements for product warranties and bonds.

B. Include coverage for delamination of veneer, warping beyond specified installation tolerances, defective materials, and telegraphing core construction.

C. Provide five year warranty for interior and exterior doors.

PART 2 PRODUCTS

2.1 FLUSH WOOD DOORS

A. Manufacturer: Any internationally recognized manufacturer having an official technical agreement to conformity with standards for the product.

B. Product Description: Solid or hollow core flush wood doors; wood veneer, plastic laminate, or hardboard facing material; fire rated or non-rated types; flush glazed design; with or without louvers; factory pre-fit; shop finished or site finished.
   1. Flush Doors: Solid core, five or seven ply construction, fire rated and/or acoustic rated as indicated on Drawings.
   2. Transom Panels: To match door, face veneer to end match, fire rated and acoustic rated as indicated on Drawings.

2.2 MATERIALS

A. Particle Board Core: Single thickness slab of 3 ply particle board complying with ANSI A208.1, Grade 1-L-1, average density not less than between 448-512 kg/m3, hot pressed with synthetic resin glue. Linear expansion shall not exceed 0.03% in either direction when tested in accordance with ASTM D1037, Sections 76 through 79. Faces of core slab shall be of 0.254mm thick flakes, with resin content a minimum of 50% higher than core resin content. Face layer density shall be a minimum of 25% higher than core density.

B. Plastic Laminate: 1mm thick; color as selected from manufacturer’s standard patterns.
   1. Acceptable manufacturers:
      a. Fromica Corporation or equal approved.

C. Mineral Core: Incombustible mineral composition free of asbestos fiber.

D. Top and Bottom Edge Bands: Thoroughly kiln dried hardwood, free from defects

which will be visible when finished as specified herein.

E. Blocking: Manufacturers standard for purpose intended.

F. Side Edge Bands: Thoroughly kiln dried hardwood, free from defects which will be visible when finished as specified herein.
   1. Wood for side edge bands shall match face veneers for natural finish doors.

G. Crossbands: Minimum 1.6 mm thick after sanding, properly dried hardwood.

H. Face Veneer for Natural Finish: Standard thickness, thoroughly dried conforming to CS35, Premium Grade. Match faces of doors in pairs. Face veneer shall be tapeless spliced with grain running vertically, belt and polish sanded, of the following species:
   1. As described in the relevant sections of Division 6: Wood and Plastics.

I. Face Veneer For Interior Painted Finish: Standard thickness sound grade hardwood veneer conforming to CS35, overlaid with medium density cellulose fiber sheets impregnated with phenolic resin.

J. Type I Adhesive: CS35, Type I (fully waterproof bond).

K. Type II Adhesive: CS35, Type II (water-resistant bond).

L. Solid Core, Non-Rated: AWI Section 1300, Type PC - Particleboard.

M. Solid Core, Fire Rated: AWI Section 1300, Type FD 1-1/2, FD 1, FD 3/4, FD 1/2 and/or FD 1/3.

N. Solid Core, Special Function: AWI Section 1300.

O. Hollow Core: AWI Section 1300, Type SHC - Standard and/or IHC - Institutional.

P. Exterior Veneer Facing: AWI Premium, Custom and/or Economy quality wood, with matched grain and transoms. Pair match multiple door leaves in single opening.
   1. Wood: As indicated on drawings.

Q. Interior Veneer Facing: AWI Premium, Custom and/or Economy quality wood, with matched grain and transoms. Pair match multiple door leaves in single opening.
   1. Wood: As indicated on drawings.

R. Plastic Laminate Facing (Interior): NEMA LD-3, General and/or Special Purpose, Fire Rated Type, 1.3 mm thick, finish, color and pattern, as indicated on drawings.

S. Cross Banding Behind Laminate Finish: as per manufacturer’s standard construction.

2.3 PRODUCTS

A. Non-fire Rated or Fire Rated Doors (30 or 60 Minutes): Exterior wood doors conforming to the following:
   1. Door Leaf: 50 mm thick solid core closed lathes.
   2. Door Frame: Solid wood.

3. Door Leaf and Door Frame Finish: Polyurethane paint.

B. Non-fire Rated or Fire Rated Doors (30 or 60 Minutes): Interior wood doors conforming to the following:
   1. Door Leaf: 45 mm thick solid MDF wood door leaf with approved wood veneer and reinforced with solid wood for lock and handle.
   2. Door Frame: Solid wood (Boie de Suède).
   3. Door Leaf and Door Frame Finish: Lacquer paint.

C. Wood Veneer: AWI Grade 1, premium 0.5mm thick before sanding.
   1. Hardwood Veneer: HPVA Grade AA, unless otherwise indicated. Suitable for transparent finish.
   2. Veneer match per leaf: Bookmatched, unless otherwise indicated.
   3. Veneer match for pairs of doors: Pair or set matched.
   4. Stain color: Custom to match Architect's sample.
   5. Finish: Pre-finished in compliance with AWI 1500-G-7, catalyzed polyurethane or catalyzed varnish finish with a satin sheen, meeting or exceeding performance characteristics of AWI System TR-6.

D. Opaque Facing (MDO): ANSI A 135.4 Type S2S, composition face, 3mm thick, for paint finish.

E. Facing and Crossband Adhesive: Type I, waterproof.

F. Transoms: Match door construction, veneers, rating and finish.

G. Vision Frames:
   1. Exterior doors: Aluminum flashing under wood lipped frames at opening sill.
   2. Non-rated doors: Flush wood frames, hardwood to match facing.
   3. Fire rated doors: Provide manufacturer's tested metal clip or comparable system with wood stop appearance.
   4. Fire-rated doors: UL approved slimline metal trim.

H. Fabricate fire-rated doors in compliance with UL or WHI requirements.

I. Laminate 5-ply door facing, cross banding and assembled core in a hot press.

J. Factory sand assembled door leaf.

K. Fire-rated Door Stiles: Manufacturer's tested reinforced stiles at doors with fire ratings greater than 60 minutes.
   1. Bond stiles and rails to core. Sand for uniform thickness.

L. Fire Rated Pair of Doors; greater than 60 minutes: Provide full length steel astragal attached to secure side of opening, projecting not less than 19mm, unless hardware specified allows both doors to be active. Coordinate with Section 08710.

M. Fire Rated Pair of Doors; greater than 60 minute: if an astragal is required, to comply with fire rated labeling requirements for pairs of fire rated doors, provide door manufacturer's standard tested astragal.
   1. Shop apply astragals.

2. shop apply matching veneer wrap to conceal metal astragal at wood faced doors.

N. Fire Rated Pair of Doors; 60 minutes: Door manufacturer's standard tested edge type.

O. Meeting Edge at Non-rated Pairs: Fabricate edge type between pairs of non-fire doors with non bevel, unless otherwise indicated.

P. Meeting Edge at Transoms: Fabricate with rabbeted edge on door and transom, unless otherwise indicated.

Q. At exterior doors, provide aluminum flashings at top and bottom rails, and at sill of glazed opening full thickness of door.

R. Cut and configure exterior door edges to receive (surface or recessed) weather stripping devices.

S. Factory finish doors in conformance with AWI Quality Standards Section 1500.
1. Apply finish to wood veneer face plys and wood edges.
2. AWI Section 1500, satin-medium rubbed, System 3 transparent, conversion varnish alkyd-urea, premium quality.

2.4 ACCESSORIES

A. Wood Louvers:
1. Material and Finish: As indicated on drawings.
2. Louver Blade: Flush, chevron or stock louver.
3. Louver Free Area: As indicated on drawings.

B. Metal Louvers:
1. Material and Finish: Roll formed steel, galvanized or prime painted; or aluminum or extruded aluminum, pre-painted finish; color as selected.
2. Louver Blade: Inverted V, Y or slat blade; fire rated with fusible link design to UL or FM requirements.
3. Louver Free Area: As indicated on drawings.
4. Frame: As indicated on drawings.

C. Glazing Stops: Wood to match door facing, or wood with metal clips for rated doors.

2.5 FABRICATION

A. Fabricate non-rated doors in accordance with AWI Quality Standards requirements.

B. Fabricate fire rated doors in accordance with AWI Quality Standards and to UL or Intertek Testing Services (Warnock Hersey Listed) requirements. Attach fire rating label and temperature rise label to door.

C. Astragals for Fire Rated Double Doors: Steel and/or Treated wood, T shaped, overlapping and recessed at face edge and/or at mid-door thickness, specifically for double doors.

D. Sound Rating for Single Door Leaf and Frame Assembly: ASTM E413, STC 35.

E. Furnish lock blocks at lock edge and top of door for closer for hardware reinforcement.

F. Vertical Exposed Edge of Stiles: Of same species as veneer facing.

G. Fit door edge trim to edge of stiles after applying veneer facing.

H. Bond edge banding to cores.

I. At exterior doors, furnish aluminum flashing at top and bottom rail and sill of glazed openings for full thickness and width of door.

J. Factory machine doors for finish hardware in accordance with hardware requirements and dimensions. Do not machine for surface hardware. Furnish solid blocking for through bolted hardware.

K. Factory fit doors for frame opening dimensions identified on shop drawings.

L. Cut and configure exterior door edge to receive recessed weather stripping devices.

M. Provide edge clearances in accordance with AWI 1300.

2.6 SHOP FINISHING

A. Factory finish doors in accordance with approved sample.

B. Seal door top edge with color and/or clear sealer to match door facing.

PART 3 EXECUTION

3.1 EXAMINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Verify opening sizes and tolerances are acceptable.

C. Do not install doors in frame openings that are not plumb or are out-of-tolerance for size or alignment.

3.2 INSTALLATION

A. Install fire rated and non-rated doors in accordance with AWI Quality Standard, NFPA 80, and to requirements for fire rating label by UL or Intertek Testing Services (Warnock Hersey Listed).

B. Trim non-rated door width by cutting equally on both jamb edges.

C. Trim door height by cutting bottom edges to maximum of 19 mm.
   1. Trim fire door height at bottom edge only, in accordance with fire rating requirements.

D. Machine cut doors for hardware installation.

E. Coordinate installation of doors with installation of frames specified in Section 08115 for wood doors having metal frames, and hardware specified in Section 08710.

F. Install door louvers plumb and level.

G. Coordinate installation of glass and glazing specified in Section 08800.

H. Site finish doors in accordance with Section 09900.

3.3 INSTALLATION TOLERANCES

A. General Requirements: Quality requirements for tolerances.

B. Conform to AWI requirements for fit and clearance tolerances.

C. Conform to AWI Section 1300 requirements for maximum diagonal distortion.

D. Maximum Vertical Distortion (Bow): 3 mm measured with straight edge or taut string, top to bottom, over imaginary 915 x 2,130 mm surface area.

E. Maximum Width Distortion (Cup): 3 mm measured with straight edge or taut string, edge to edge, over imaginary 915 x 2,130 mm surface area.

3.4 ADJUSTING

A. General Requirements: Execution requirements for testing, adjusting and balancing.

B. Adjust door for smooth and balanced door movement.

C. Adjust closer for full closure.

3.5 SCHEDULES

A. As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 08310

ACCESS DOORS AND PANELS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes fire resistive rated and non-rated access doors and panels with frames.
   1. Provide for access to controls, valves, traps, dampers, cleanouts, and similar items requiring operation behind inaccessible finished surfaces.
   2. Coordinate exact locations with various trades to assure proper placement of access doors and panels.

B. Related Sections:
   1. Section 03100 - Concrete Forms and Accessories: Placement of access frame unit anchors in concrete.
   2. Section 09900 - Paints and Coatings: Field paint finish.
   3. Division 15 - Mechanical: Duct Accessories (Access doors in ductwork).

1.2 REFERENCES

A. National Fire Protection Association:
   1. NFPA 80 - Standard for Fire Doors, Fire Windows.

B. Underwriters Laboratories Inc.:
   1. UL - Building Materials Directory.

C. Intertek Testing Services (Warnock Hersey Listed):
   1. WH - Certification Listings.

1.3 DESIGN REQUIREMENTS

A. Fabricate floor access assemblies to support live load of 4.7 kPa with deflection not to exceed 1/180 of span.

1.4 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

B. Shop Drawings: Indicate exact position of access door units.

C. Product Data: Submit literature indicating sizes, types, finishes, hardware, scheduled locations, fire resistance listings, and details of adjoining Work.

D. Samples: Submit two 300 x 300 mm in size illustrating frame configuration and anchors.

E. Manufacturer's Installation Instructions: Submit installation requirements and roughin dimensions.

1.5 CLOSEOUT SUBMITTALS

A. General Requirements: Execution requirements for closeout procedures.

B. Project Record Documents: Record actual locations of access units.

1.6 QUALITY ASSURANCE

A. Fire Resistance Ratings (where stated): Provide assemblies from manufacturers listed in UL Directory or Intertek Testing Services (Warnock Hersey Listed) Directory.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified with minimum ten years documented experience.

1.8 COORDINATION

A. General Requirements: Administrative requirements for coordination.

B. Coordinate Work with work requiring controls, valves, traps, dampers, cleanouts, and similar items requiring operation being located behind finished surfaces.

PART 2 PRODUCTS

2.1 ACCESS DOORS AND PANELS

A. Manufacturer: Any internationally recognized manufacturer having an official technical agreement to conformity with standards for the product.

2.2 FABRICATION

A. Fabricate units of continuous welded construction; weld, fill, and grind joints to assure flush and square unit.

B. Wall and Ceiling Access Door and Panel Hardware:
1. Hinge: Standard continuous or concealed spring pin type, 175º steel hinges.
2. Lock: Self-latching lock.

C. Floor Hatch Hardware:
1. Hinge: 175º stainless steel type 316 hinges with removable pin.
2. Lock: Self-latching lock or cylinder lock with latch, two keys for each unit.

D. Size Variations: Obtain acceptance of manufacturer’s standard size units which vary slightly from sizes shown or scheduled.

2.3 SHOP FINISHING

A. Base Metal Protection: Galvanized, hot dipped finish.

B. Finish: Stainless Steel Type 316: No. 4 finish.

PART 3 EXECUTION

3.1 EXAMINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Verify rough openings for access doors and panels are correctly sized and located.

3.2 INSTALLATION

A. Secure frames rigidly in place, plumb and level in opening, with plane of door and panel face aligned with adjacent finished surfaces.
   1. Set concealed frame type units flush with adjacent finished surfaces.

B. Position unit to provide convenient access to concealed work requiring access.

C. Install fire rated units in accordance with NFPA 80 and requirements for fire listing.

3.3 SCHEDULES

A. As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 08520

ALUMINUM DOORS AND WINDOWS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes extruded aluminum windows and doors with fixed and operating sash, factory glazed panels, operating hardware and insect screens.

B. Related Sections:
1. Section 05500 - Metal Fabrications.
2. Section 07260 - Vapor Retarders.
3. Section 07270 - Air Barriers.
4. Section 07900 - Joint Sealers.
5. Section 08160 - Sliding Metal Doors and Grilles.
6. Section 08800 - Glazing.

1.2 REFERENCES

A. Aluminum Association:
1. AA DAF-45 - Designation System for Aluminum Finishes.

B. American Architectural Manufacturers Association:
1. AAMA 101 - Voluntary Specifications for Aluminum, Vinyl (PVC) and Wood Windows and Glass Doors.
2. AAMA 501.4 - Recommended Static Test Method for Evaluating Curtain Wall and Storefront Systems Subjected to Seismic and Wind Induced Inter Story Drifts.
3. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.
4. AAMA 1503 - Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.
5. AAMA 2604 - Voluntary Specification, Performance Requirements and Test Procedures for High Performance Organic Coatings on Aluminum Extrusions and Panels.
6. AAMA MCWM-1 - Metal Curtain Wall manual.

C. American National Standards Institute:
1. ANSI Z97.1 - Safety Glazing Materials Used in Buildings Safety.

D. American Society of Civil Engineers:
1. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.

E. ASTM International:
1. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
2. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
3. ASTM B221M - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric).

4. ASTM D1784 - Standard Specification for Rigid Poly Vinyl Chloride (PVC) Compounds and Chlorinated Poly Vinyl Chloride (CPVC) Compounds.
5. ASTM D3656 - Standard Specification for Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns.
6. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences across the Specimen.
7. ASTM E330 - Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
8. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
9. ASTM E547 - Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Cyclic Static Air Pressure Differential.
10. ASTM E1105 - Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Curtain Walls, and Doors by Uniform or Cyclic Static Air Pressure Difference.
11. ASTM F588 - Standard Test Methods for Resistance of Window Assemblies to Forced Entry Excluding Glazing.

F. Glass Association of North America:
1. GANA - Glazing Manual.

G. National Fenestration Rating Council Incorporated:
1. NFRC 100 - Procedures for Determining Fenestration Product U-Factors.

H. SSPC: The Society for Protective Coatings:
1. SSPC Paint 20 - Zinc-Rich Primers (Type I - Inorganic and Type II -Organic).
2. SSPC Paint 25 - Red Iron Oxide, Zinc Oxide, Raw Linseed Oil, and Alkyd Primer.

1.3 SYSTEM DESCRIPTION

A. Doors and windows system shall provide the acceptable level of air tightness and water tightness against wind driven rain.

B. Windows: Tubular or single thickness aluminum sections, factory fabricated, factory finished, factory glazed vision glass, related flashings, anchorage and attachment devices.

C. Configuration: Conform to AAMA 101, designations for windows required for Project.

D. Glazing: Interior and exterior.

E. Forced Entry Resistance: Conform to ASTM F588.

1.4 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

B. Design Drawings and Calculations: Show that system is able to support applied loads.

C. Shop Drawings: Indicate opening dimensions, framed opening tolerances, affected

related Work; and installation requirements.

D. Product Data: Submit component dimensions, anchorage and fasteners, glass, internal drainage, and typical details.

E. Samples: Submit two samples 600 x 600 mm in size, illustrating window frame section mullion section, screen and frame, factory finished aluminum surfaces, glass units, glazing materials. Submit two samples of operating hardware.

F. Manufacturer's Certificates: Certify Product performance ratings by independent third party such as AAMA, CAWM, or NFRC as meeting specified requirements.

G. Test Reports: Indicate substantiating engineering data, test results of previous tests by independent laboratory which purport to meet performance criteria, and other supportive data.

1.5 MOCKUP

A. General Requirements: Quality requirements for mockup.

B. Construct mockups, full size including all hardware and attachment accessories.

C. Locate where directed by the Engineer.

D. Remove mockup when directed by the Engineer.

E. Test mock-ups according to relevant standards.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with the following:
1. Aluminum Windows: Fabricate window assemblies in accordance with AAMA 101 for types of windows required.
2. Insulated Glass: Fabricate insulated glass units in accordance with GANA (formerly FGMA) Glazing Manual.
3. Safety Glass: Conform to ANSI Z97.1 and applicable codes.
4. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing commercial and institutional aluminum windows with minimum ten years documented experience.

B. Installer: Company specializing in installation of commercial and institutional aluminum windows with minimum five years documented experience.

1.8 PRE-INSTALLATION MEETINGS

A. General Requirements: Administrative requirements for pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND PROTECTION

A. General Requirements: Product requirements for product storage and handling.

B. Handle Work of this section in accordance with AAMA MCWM-1 - Curtain Wall Manual #10.

C. Protect factory finished aluminum surfaces with wrapping and/or strippable coating. Do not use adhesive papers or sprayed coatings that bond when exposed to sunlight or weather.

1.10 ENVIRONMENTAL REQUIREMENTS

A. General Requirements: Product requirements.

B. Do not install glazing materials when ambient temperature is less than 10ºC.

C. Maintain this minimum temperature during and after installation of glazing materials.

1.11 WARRANTY

A. General Requirements: Execution requirements for product warranties and bonds.

B. Furnish ten year manufacturer warranty for system.

C. Warranty: Include coverage for degradation of color finish and seal failure.

PART 2 PRODUCTS

2.1 ALUMINUM WINDOWS

A. Manufacturer: Any internationally recognized manufacturer having an official technical agreement to conformity with standards for the product.

2.2 COMPONENTS

A. Extruded Aluminum: ASTM B221M; 6063 alloy, T5 temper.

B. Sheet Aluminum: ASTM B209M; 5005 alloy, H15 or H34 temper.

C. Steel Sections: Profiled to suit mullion sections.

D. Thermally broken aluminum frame where explicitly shown on drawings.

E. Glass: Conforming to requirements of Section 08800.

F. Hardware:
1. Operator: Geared rotary handle fitted to projecting sash arms with limit stops.
2. Projecting Sash Arms: Cadmium or zinc plated steel, friction pivot joints with nylon bearings, removable pivot clips for cleaning.

3. Pulls: Manufacturer's standard.
4. Sash lock: Lever handle with cam lock.
5. Bottom Rollers: Stainless steel type 316, adjustable.

G. Sills: Extruded aluminum; sloped for positive wash; fit under sash leg 12 mm beyond wall face; one piece full width of opening jamb angles to terminate sill end.

H. Operable Sash Weather Stripping: Wool pile, nylon pile or resilient plastic; permanently resilient, profiled to effect weather seal.

2.3 ACCESSORIES

A. Fasteners and Anchors: Stainless steel type 316.

B. Visual Glass Dividers: Formed aluminum, fitted against interior of glazed surface, secured with spring loaded steel pins into plastic sockets.

C. Visual Glass Muntins: Formed aluminum, applied to interior and/or exterior glass surface.

D. Bituminous Paint: Fibered asphaltic type.

E. Limit Stops: Resilient rubber.

2.4 FABRICATION

A. Wherever possible, the doors/windows should be prefabricated, transported to site and installed without scaffolding. This allows superior quality control during fabrication and quick installation.

B. The panels will be transported to site and craned to the appropriate floor.

C. All occupational health and safety issues should be adequately addressed for the installation.

D. Fabricate components with minimum clearances and shim spacing around perimeter of assembly, yet enabling installation and dynamic movement of perimeter seal.

E. Accurately fit and secure joints and corners. Make joints flush, hairline, and weatherproof.

F. Prepare components to receive anchor devices. Fabricate anchors.

G. Arrange fasteners and attachments to ensure concealment from view.

H. Prepare components with internal reinforcement for operating hardware.

I. Furnish internal reinforcement in mullions with galvanized steel members to maintain rigidity.

J. Permit internal drainage weep holes and channels to migrate moisture to exterior.

Furnish internal drainage of glazing spaces to exterior through weep holes.

K. Assemble insect screen frame, miter and reinforce frame corners. Fit mesh taut into frame and secure. Fit frame with four spring loaded steel pin retainers.

L. Double and/or single weatherstrip operable units.

M. Factory glaze window units. Install glass panels in accordance with Section 08800.

2.5 SHOP FINISHING

A. Finish Coatings: Conform to AAMA 2603, AAMA 2604 or 2605 and/or AAMA 611.

B. Exterior and Interior Aluminum Surfaces: Advanced Durability Polyester Powder Coating System. Color: As selected. Minimum cover Thickness 60 microns. Percent Gloss: As selected.

C. If anodized finishes are adopted, Color Anodized Aluminum Surfaces: AAM12C22A44 non-specular as fabricated mechanical finish, medium matte chemical finish and Architectural Class I, 0.018mm anodized coating; Color as selected.

D. Locks, Operators, and Exposed Hardware: Enameled to match window finish and/or color as directed by the Engineer.

E. Pull Handles: Prefinished wood with aluminum brackets, and/or Anodized aluminum. Color to match frames.

F. Screens: Black, White, and/or Gray color.

G. Apply coat of bituminous paint on concealed aluminum surfaces in contact with cementitious or dissimilar materials.

H. Shop and Touch-Up Primer for Steel Components: SSPC Paint 25 red oxide.

I. Touch-Up Primer for Galvanized Steel Surfaces: SSPC Paint 20 zinc rich.

J. Concealed Steel Items: Galvanized in accordance with ASTM A123/A123M to thickness Grade 85, 610 g/sq m.

PART 3 EXECUTION

3.1 EXAMINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Verify openings and adjoining air and vapor seal materials are ready to receive Work.

3.2 INSTALLATION

A. Attach window frame and shims to perimeter opening to accommodate construction tolerances and other irregularities.

B. Align window plumb and level, free of warp or twist. Maintain dimensional tolerances and alignment with adjacent Work.

C. Install sill and sill end angles.

D. Install thermal isolation where components penetrate or disrupt building insulation. Pack fibrous insulation in shim spaces at perimeter of assembly to maintain continuity of thermal barrier.

E. Coordinate attachment and seal of perimeter air barrier and vapor retarder materials with Section 07260 and Section 07270.

F. Install operating hardware.

3.3 ERECTION TOLERANCES

A. General Requirements: Quality requirements for tolerances.

B. Maximum Variation from Level or Plumb: 1.5 mm/m non-cumulative, or 3 mm/3m, whichever is less.

3.4 FIELD QUALITY CONTROL

A. General Requirements: Quality requirements for testing and inspection services, and execution requirements for testing, adjusting and balancing.

B. Inspection to monitor quality of installation and glazing.

C. Test to AAMA 502, ASTM E1105, and AAMA 501.

D. Perform field water test in compliance with ASTM E 1105, on completed portions of Aluminum Doors and Windows.

E. Perform one test each at 10%, 50% and 80% of Doors and Windows completion, with repeat tests when failures occur.

F. When testing results in leakage, eliminate causes of leaks and retest until no leaks occur.

3.5 ADJUSTING

A. General Requirements: Execution requirements for testing, adjusting and balancing.

B. Adjust hardware for smooth operation and secure weathertight closure.

3.6 CLEANING

A. General Requirements: Execution requirements for final cleaning.

B. Remove protective material from factory finished aluminum surfaces.

C. Wash surfaces by method recommended and acceptable to sealant and window manufacturer; rinse and wipe surfaces clean.

D. Remove excess sealant by moderate use of mineral spirits or other solvent acceptable to sealant and window manufacturer.

3.7 SCHEDULES

A. As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 08710

DOOR HARDWARE

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:
1. Hardware for wood doors.
2. Hardware for metal doors.

B. Related Sections:
1. Section 06200 - Finish Carpentry: Wood door frames.
2. Section 06410 - Custom Cabinets: Cabinet hardware.
3. Section 08114 - Standard Steel Doors.
4. Section 08115 - Standard Steel Frames.
5. Section 08212 - Flush Wood Doors.
6. Section 08310 - Access Doors and Panels.
7. Section 08335 - Overhead Coiling Strip Doors.
8. Section 10440 - Interior Signage.
9. Division 16 - Electrical: Power supply to electric hardware devices.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI A156.1 - Butts and Hinges.
2. ANSI A156.2 - Bored and Preassembled Locks and Latches.
3. ANSI A156.3 - Exit Devices.
4. ANSI A156.4 - Door Controls - Closures.
5. ANSI A156.5 - Auxiliary Locks and Associated Products.
6. ANSI A156.6 - Architectural Door Trim.
7. ANSI A156.7 - Template Hinge Dimensions.
8. ANSI A156.8 - Door Controls - Overhead Holders.
9. ANSI A156.12 - Interconnected Locks and Latches.
10. ANSI A156.13 - Mortise Locks and Latches.
11. ANSI A156.14 - Sliding and Folding Door Hardware.
12. ANSI A156.15 - Closer Holder Release Devices.
13. ANSI A156.16 - Auxiliary Hardware.
14. ANSI A156.18 - Materials and Finishes
15. ANSI A156.19 - Power Assist and Low Energy Power Operated Doors.
16. ANSI A156.23 - Electromagnetic Locks.
17. ANSI A156.24 - Delayed Egress Locks.
18. ANSI A156 - Complete Set of 24 BHMA (A156 Series) with Binder.

B. Builders Hardware Manufacturers Association:
1. BHMA Directory of Certified Products.

C. National Fire Protection Association:
1. NFPA 80 - Standard for Fire Doors, Fire Windows.
2. NFPA 252 - Standard Methods of Fire Tests of Door Assemblies.

D. Underwriters Laboratories Inc.:
   1. UL 10B - Fire Tests of Door Assemblies.
   2. UL 305 - Panic Hardware.
   3. UL - Building Materials Directory.

E. Intertek Testing Services (Warnock Hersey Listed):
   1. WH - Certification Listings.

1.3 PERFORMANCE REQUIREMENTS

A. Fire Rated Openings: Provide door hardware listed by UL or Intertek Testing Services (Warnock Hersey Listed), or other testing laboratory approved by applicable authorities.
   1. Hardware: Tested in accordance with NFPA 252.

1.4 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

B. Shop Drawings:
   1. ndicate locations and mounting heights of each type of hardware, schedules, catalog cuts, electrical characteristics and connection requirements, and fixing details.
   2. Submit manufacturer's parts lists, and templates.

C. Samples:
   1. Submit one sample of typical hinge, latchset, lockset and closer, illustrating style, color and finish.
   2. Approved samples might be incorporated into Work.

D. Manufacturer's Installation Instructions: Submit special procedures, and perimeter conditions requiring special attention.

1.5 CLOSEOUT SUBMITTALS

A. General Requirements: Execution requirements for closeout procedures.

B. Project Record Documents: Record actual locations of installed cylinders.

C. Operation and Maintenance Data: Submit data on operating hardware, components, lubrication requirements, and inspection procedures related to preventative maintenance.

D. Keys: Deliver with identifying tags to Owner by security shipment direct from hardware supplier.

1.6 QUALITY ASSURANCE

A. Perform Work in accordance with ANSI A156 series, NFPA 80 and UL 305.

B. Furnish hardware marked and listed in BHMA Directory of Certified Products.

C. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum ten years documented experience.

B. Hardware Supplier: Company specializing in supplying commercial and institutional door hardware with minimum five years documented experience.

C. Hardware Supplier Personnel: Employ approved qualified person to assist in work of this section.

D. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc., as suitable for purpose specified and indicated.

1.8 PRE-INSTALLATION MEETINGS

A. General Requirements: Administrative requirements for pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

C. Include persons involved with installation of doors, frames and hardware.

1.9 DELIVERY, STORAGE AND HANDLING

A. General Requirements: Product requirements for product storage and handling.

B. Package hardware items individually with necessary fasteners, instructions, and installation templates, when necessary; label and identify each package with door opening code to match hardware schedule.

1.10 COORDINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Coordinate Work with other directly affected sections involving manufacture or fabrication of internal reinforcement for door hardware and recessed items.
   1. Provide templates or actual hardware as required to ensure proper preparation of doors and frames.

C. Sequence installation to accommodate required utility connections.

D. Coordinate Owner's keying requirements during course of Work.

1.11 WARRANTY

A. General Requirements: Execution requirements for product warranties and bonds.

B. Furnish five year manufacturer warranty for locksets and door closers.

1.12 MAINTENANCE MATERIALS

A. General Requirements: Execution requirements for maintenance materials.

B. Furnish special wrenches and tools applicable for each different and for each special hardware component.

C. Furnish maintenance tools and accessories supplied by hardware manufacturer.

1.13 EXTRA MATERIALS

A. General Requirements: Execution requirements for spare parts and maintenance products.

B. Furnish ten extra key lock cylinders for each master keyed group.

PART 2 PRODUCTS

2.1 DOOR HARDWARE

A. Hinge, Pivots, Lockset, Latch Set, Exit Device, Electric Strike and/or Lock, Cylinder, Closers, Door Controls and Overhead Holders, Sliding and/or Bi-Folding Door Hardware, Push/Pulls, Manual and/or Automatic Bolts, Protection Plates, Gaskets, Thresholds and Trim Manufacturers: Any internationally recognized manufacturer having an official technical agreement to conformity with standards for the products.

2.2 COMPONENTS

A. General Hardware Requirements: Where not specifically indicated, comply with applicable ANSI A156 standard for type of hardware required. Furnish each type of hardware with accessories as required for applications indicated and for complete, finished, operational doors.
   1. Templates: Furnish templates or physical hardware items to door and frame manufacturers sufficiently in advance to avoid delay in Work.
   2. Reinforcing Units: Furnished by door and frame manufacturers; coordinated by hardware supplier or hardware manufacturer.
   3. Fasteners: Furnish as recommended by hardware manufacturer and as required to secure hardware. Finish to match hardware item being fastened.
   4. Fire Ratings: Provide hardware with UL or Intertek Testing Services (Warnock Hersey Listed) listings for type of application involved.
   5. Electrical Devices: Make provisions and coordinate requirements for electrical devices and connections for hardware.

B. Hinges: To EN1935 class 13; 40 hours salt test; 3 mm thick stainless steel type 316 material; 5 knuckles; with stainless steel type 316 pin, removable at interior, nonrising pin housed in ball bearing.
   1. Width: Sufficient to clear trim projection when door swings 180 degrees.
   2. Number: Furnish minimum three hinges for each door leaf up to 2200 mm high, and four hinges for each door leaf not exceeding 3050 mm high.
   3. Size and Weight: 114 mm high heavy weight for door leaf up to 44 mm thick and up to 1200 mm wide, and 125 mm high extra heavy weight ball or iolite

bearing hinges for door leaf exceeding 44 mm thick or 1200 mm wide.

C. Pivots: ANSI A156.1 and A156.4, center or offset full mortise pivots.
   1. Size: As recommended by pivot manufacturer for size and weight of door.

D. Locksets: Furnish locksets compatible with specified cylinders. Typical 70 mm backset. Furnish standard strikes with extended lips to protect trim from being marred by latch bolt, verify type of cutouts provided in metal frames.
   1. Mortise Locksets: ANSI A156.13, Series 1000, Grade 1.
   2. Bored (Cylindrical) Locksets: ANSI A156.2, Series 4000, Grade 1.
   3. Preassembled (Unit) Locksets: ANSI A156.12, Series 2000, Grade 1.
   4. Interconnected Locksets: ANSI A156.12, Series 5000, Grade 1.
   5. Auxiliary Locksets: ANSI A156.5, Grade 1, mortise dead locks, bored dead locks, rim locks or narrow stile locks.

E. Latch Sets: Match locksets.
   1. Mortise Latch Sets: ANSI A156.13, Series 1000, Grade 1, 2 or 3.
   2. Bored (Cylindrical) Latch Sets: ANSI A156.2, Series 4000, Grade 1, 2 or 3.

F. Exit Devices: ANSI A156.3, Grade 1, concealed vertical rod type or rim type, with push pad or cross bar. Furnish standard strikes with extended lips to protect trim from being marred by latch bolt, verify type of cutouts provided in metal frames, with dustproof floor strikes.
   1. Types: Suitable for doors requiring exit devices.
   2. Coordinators: Furnish overhead concealed in frame type at pairs of doors.

G. Cylinders: To DIN V18254 and to ANSI A156.5, Grade 1, 5, 6, or 7, pin type removable cylinders, or interchangeable core type cylinders; Euro profile, length to suit door thickness; single, double or with turn where indicated; non copiable, protected with anti drill option from outside; nickel-plated finish or to suit finish of handle.
   1. Locks and cylinders shall be keyed as per Engineer’s instruction.
   2. Keys: Nickel silver finish. Provide three keys per lock.

H. Lock: To BS 5872.
   1. Sash Lock: 76mm lock case, 57mm backset centers to suit Euro profile cylinder, stainless steel type 316, for end plate and strike plate, brass latch and deadbolt, deadbolt with hardened steel rollers.
   2. Deadlock: Same as sash lock without latch.
   3. Latch lock: Same as sash lock without deadlatch.
   4. Bathroom Lock: Special cylinder with thumbturn lock system with normal deadbolt to suit 8 or 5mm indicator and turn spindle.
   5. Nightlatch: Same as sash lock, cylinder to withdraw latch.

I. Electric Strikes and Locks: ANSI A156.5 mortised or rim mounted, semi rim mounted electric strikes, ANSI A156.23 electromagnetic locks, or ANSI A156.24 delayed egress locks.

J. Closers: ANSI A156.4 modern type with or without cover, stainless steel type 316 or to match door hardware on same face of door, surface mounted, overhead concealed, concealed in door, or concealed in floor center pivot or offset pivot closers; full rack

and pinion type with steel spring and non-freezing hydraulic fluid.

1. Adjustability: Furnish controls for regulating closing, latching, speeds, and back checking.
2. Arms: Type to suit individual condition; parallel-arm closers at reverse bevel doors and where doors swing full 180 degrees.
3. Location: Mount closers on inside of exterior doors, room side of interior doors typical; mount on pull side of other doors.
4. Operating Pressure: Maximum operating pressure as follows:
    a. Interior Doors: Maximum 22 N.
    b. Exterior Doors: Maximum 38 N.
    c. Fire Rated Doors: As required for fire rating, maximum 65 N.

K. Door Controls and Overhead Holders: Furnish with accessories as required for complete operational installation.

1. Manual Door Holders and Overhead Stops: ANSI A156.8, Grade 1 types as specified.
2. Closer Holder Release Devices: ANSI A156.15 door mounted, jamb mounted, or concealed mounted closer holder release devices, or closers with single or multiple point hold open or free swinging release device designed to make swing doors close upon receiving electrical signal.
3. Electro-Magnetic Door Holder: ANSI A156.15 wall or floor mounted type.
4. Power Assist Door Operators: ANSI A156.19 power mechanism which reduces opening resistance of self-closing door.
5. Low Energy Power Door Operators: ANSI A156.19 power mechanism which opens and closes door upon receipt of signal.
6. Low Energy Power Open Door Operators: ANSI A156.19 power mechanism which opens self-closing door; closing of door independent of power operator.

L. Sliding and Bi-Folding Door Hardware: ANSI A156.14; furnish complete hardware sets for operational installation.

M. Door Stop: ANSI A156.1, Grade 1; stainless steel type 316 material, cylindrical or dome type with rubber and with no visible screws, to be fixed at minimum _ of door width from Hinge side. Furnish with accessories as required for applications indicated.

N. Handles: Stainless steel type 316 satin finish, hollow type with bolt through fixing screws, return to door type.

O. Pull handle: Stainless steel type 316; bolt through fixing type.

P. Push/Pulls, Manual and Automatic Bolts, Protection Plates, Gaskets, Thresholds and Trim: Furnish with accessories as required for complete operational door installations.

1. Push/Pulls: ANSI A156.6; push plates minimum 1.27 mm thick. Furnish pulls with bolts to secure from opposite door face.
2. Manual and Automatic Constant Latching Bolts: ANSI A156.16 Grade 1 top and bottom flush bolts, with dust-proof floor strike.
3. Kickplates Mop Plate, Armor Plate and Door Edging: ANSI A156.6; height 25 mm less than door width; minimum 1.27mm thick stainless steel type 316.
4. Weatherstripping: Continuous at top and sides of exterior doors.
5. Fire Rated Gaskets: Continuous at top and sides of fire rated doors.
6. Thresholds: Maximum 12 mm height.

2.3 ACCESSORIES

A. Lock Trim: Furnish levers as selected from manufacturer's range of levers and roses.

B. Through Bolts: Do not permit through bolts and grommet nuts on door faces in occupied areas unless no alternative is possible. Do not permit through bolts on solid wood core doors.

C. Flush Bolt:
   1. All flush bolts for metal doors to be of type suitable for metal doors with rod length 305mm, size 25 x 172mm.
   2. All flush bolts for wood doors to be 19 x 200mm size, lever action type.

D. Key Cabinet:
   1. Cabinet Construction: Aluminum or sheet steel construction, baked enamel finish; color as selected; piano hinged door.
   2. Cabinet Size: Size to suit project keys plus 10 percent.
   3. Horizontal metal or plastic strips for key hook labeling with clear plastic strip cover over labels.

2.4 FINISHING

A. Finishing of Other Hardware Items: Furnish manufacturer's standard finishes to match similar hardware types on same door, and maintain acceptable finish considering anticipated use and BHMA category of finish.

PART 3 EXECUTION

3.1 EXAMINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Verify doors and frames are ready to receive door hardware and dimensions are as indicated on shop drawings and as instructed by manufacturer.

C. Verify electric power is available to power operated devices and is of correct characteristics.

3.2 INSTALLATION

A. Mounting Heights of Hardware Item:
   1. Coordinate mounting heights with door and frame manufacturers.
   2. Comply with manufacturer's recommendations, and applicable standards and codes where not otherwise stated.

B. Install Work in accordance with the drawings, to the manufacturer's instructions and to the satisfaction of the Engineer.

3.3 FIELD QUALITY CONTROL

A. General Requirements: Quality requirements for testing and inspection services, and execution requirements for testing, adjusting and balancing.

B. Primary hardware manufacturer’s representatives shall inspect installation and certify that hardware has been furnished and installed in accordance with manufacturer's instructions and as specified.

3.4 ADJUSTING

A. General Requirements: Execution requirements for testing, adjusting and balancing.

B. Adjust hardware for smooth operation.

3.5 PROTECTION OF INSTALLED CONSTRUCTION

A. General Requirements: Execution requirements for protecting installed construction.

B. Do not permit adjacent work to damage hardware or hardware finish.

3.6 SCHEDULES

A. As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 08800

GLAZING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes glass for cupboards, doors, windows, glazed walls, curtain wall, external glass cladding and glazed balustrades.

B. Related Sections:
1. Section 07260 - Vapor Retarders.
2. Section 07270 - Air Barriers.
3. Section 07900 - Joint Sealers.
4. Section 08114 - Standard Steel Doors.
5. Section 08212 - Flush Wood Doors.
6. Section 08520 - Aluminum Windows.
7. Section 10800 - Toilet, Bath and Laundry Accessories: Mirrors.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI Z97.1 - Safety Glazing Materials Used in Buildings Safety.

B. American Society of Civil Engineers:
1. ASCE 7 - Minimum Design Loads for Buildings and Other Structures.

C. ASTM International:
1. ASTM C570 - Standard Specification for Oil and Resin-Base Caulking Compound for Building Construction.
2. ASTM C669 - Standard Specification for Glazing Compounds for Back Bedding and Face Glazing of Metal Sash.
3. ASTM C864 - Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
4. ASTM C920 - Standard Specification for Elastomeric Joint Sealants.
5. ASTM C1036 - Standard Specification for Flat Glass.
6. ASTM C1048 - Standard Specification for Heat-Treated Flat Glass-Kind HS, Kind FT Coated and Uncoated Glass.
7. ASTM C1172 - Standard Specification for Laminated Architectural Flat Glass.
8. ASTM C1193 - Standard Guide for Use of Joint Sealants.
9. ASTM D4802 - Standard Specification for Poly (Methyl Methacrylate) Acrylic Plastic Sheet.
10. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
11. ASTM E330 - Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
12. ASTM E546 - Standard Test Method for Frost Point of Sealed Insulating Glass Units.
13. ASTM E576 - Standard Test Method for Frost Point of Sealed Insulating Glass Units in the Vertical Position.

14. ASTM E773 - Standard Test Methods for Seal Durability of Sealed Insulating Glass Units.
15. ASTM E774 - Standard Specification for Sealed Insulating Glass Units.
16. ASTM E1425 - Standard Practice for Determining the Acoustical Performance of Exterior Windows and Doors.

D. DIN Standards:
1. DIN 18516: Part4 – Heat Soaked Testing for Tempered Glass.

E. Glass Association of North America:
1. GANA - FGMA Sealant Manual.
2. GANA - Glazing Manual.
3. GANA - Laminated Glass Design Guide.

F. National Fire Protection Association:
1. NFPA 80 - Standard for Fire Doors, Fire Windows.

G. Underwriters Laboratories Inc.:
1. UL - Building Materials Directory.

1.3 PERFORMANCE REQUIREMENTS

A. Ensure that no glass or glazing combination develops stresses that may lead to damage of glass, glazing materials, components and/or framing systems.

B. Conduct a thermal stress analysis, undertake thermal calculations and make due allowance for any heat treated glass which may be required. Shading stresses that might occur from adjacent components and buildings including shading devices shall be taken into account.

C. For Impact Requirements: Conform to BS 6206 - Specification for impact performance requirements for flat safety glass and safety plastics for use in buildings; and BS 6262-4 - Glazing for buildings: Safety related to human impact; or equivalent.

1.4 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

B. Design Drawings and Calculations: Demonstrate that glass is able to support the applied loads.

C. Product Data:
1. Glass: Provide structural, physical and environmental characteristics, size limitations, special handling or installation requirements.
2. Glazing Sealants, Compounds and Accessories: Provide chemical, functional, and environmental characteristics, limitations, special application requirements. Identify available colors where exposed.

D. Samples:
1. Glass: Submit three samples 600 x 600 mm in size, illustrating each glass and plastic units, color and design.

2. Glazing Materials: Submit 300 mm long bead of glazing sealant and gaskets, color as selected by the Engineer.

E. Certificates: Certify that products meet or exceed specified requirements.

F. Manufacturer's Certificate: Certify that sealed insulated, environmental, laminated and/or acoustical glass meets or exceeds specified requirements.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with GANA Glazing Manual, GANA Sealant Manual, and GANA Laminated Glass Design Guide for glazing installation methods.

B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum ten years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum five years documented experience.

1.7 MOCKUP

A. General Requirements: Quality requirements for mock-up.

B. Construct mockup size as directed by the Engineer, including glass and air barrier and vapor retarder seal.

C. Locate where directed by the Engineer.

D. Remove mockup when directed by the Engineer.

E. Test mock-ups according to relevant standards.

1.8 PRE-INSTALLATION MEETING

A. General Requirements: Administrative requirements for pre-installation meeting.

B. Convene minimum one week before starting Work of this section.

1.9 ENVIRONMENTAL REQUIREMENTS

A. General Requirements: Product requirements.

B. Do not install glazing when ambient temperature is less than 10 ºC.

C. Maintain minimum ambient temperature before, during and 24 hours after installation of glazing compounds.

1.10 WARRANTY

A. General Requirements: Execution requirements for product warranties and bonds.

B. Furnish ten year warranty to include coverage for sealed glass units from seal failure, interpane dusting or misting, and replacement of same.

C. Furnish ten year warranty to include coverage for delamination of laminated glass and replacement of same.

1.11 EXTRA MATERIALS

A. General Requirements: Execution requirements for spare parts and maintenance products.

B. Supply two of each glass size and each glass type.

PART 2 PRODUCTS

2.1 GLAZING

A. Glass, Glazing, Sealant, Gasket, Tapes Compounds and Glazing Accessories Manufacturers: Any internationally recognized manufacturers having an official technical agreement to conformity with standards for the products.

2.2 COMPONENTS

A. Safety Tempered and Laminated Glass Conform to ANSI Z97.1 and ASTM C1172.

B. PVB Interlayer: Manufacturer's standard, minimum 0.76 mm thick.

C. Insulated Glass Units: Double pane to ASTM E774 Class A and E773; with glass elastomer, glass to mastic, and special acoustic edge seal; place reflective film within unit; purge interpane space with dry hermetic air.

D. All tempered glass to be heat soak tested.

E. Obtain the total quantity of each glass material from the same material manufacturer. In the case of coated glasses, or other processed glass products, the Sub-Contractor shall ensure that all products are processed from 'raw' glass material obtained from one manufacturer.

2.3 ACCESSORIES

A. Glazing Splines and Gaskets: ASTM C864 Option I, resilient neoprene, silicone, and/or polyvinyl chloride extruded shape to suit glazing channel retaining slot.

B. Setting Blocks: ASTM C864 Option I, Neoprene, EPDM, or Silicone, 80 to 90 Shore A durometer hardness, length of 25 mm for each square meter of glazing or minimum 100 mm x width of glazing rabbet space minus 1.5 mm x height to suit glazing method and pane weight and area.

C. Spacer Shims: ASTM C864 Option I, Neoprene or Silicone, 50 to 60 Shore A durometer hardness, minimum 75 mm long x one half the height of glazing stop x thickness to suit application.

D. Glazing Clips: Manufacturer's standard type.

E. Fire-Resistant Glazing Materials: Materials used to obtain required fire-resistant rating.

F. Smoke Removal Unit Targets: Adhesive targets affixed to glass to identify glass units destined for removal of smoke.

2.4 SOURCE QUALITY CONTROL AND TESTS

A. General Requirements: Quality requirements for testing and analysis.

B. Provide shop inspection and testing for safety insulated glass.

C. Test samples to ANSI Z97.1, ASTM E773, ASTM E546, and ASTM E576.

PART 3 EXECUTION

3.1 EXAMINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Verify openings for glazing are correctly sized and within acceptable tolerance.

C. Verify surfaces of glazing channels or recesses are clean, free of obstructions impeding moisture movement; weeps are clear and ready to receive glazing.

3.2 PREPARATION

A. Clean contact surfaces with solvent and wipe dry.

B. Seal porous glazing channels or recesses with substrate compatible primer or sealer.

C. Prime surfaces scheduled to receive sealant.

3.3 INSTALLATION

A. Perform installation in accordance with GANA Glazing Manual.
   1. Glazing Sealants: Comply with ASTM C1193.
   2. Fire Rated Openings: Comply with NFPA 80

B. Exterior Dry Method:
   1. Cut glazing spline to length; install on glazing pane. Seal corners by butting tape and sealing junctions with compatible butyl sealant.
   2. Place setting blocks at ¼ or _ points with edge block no more than 150 mm

from corners.

3. Rest glazing on setting blocks and push against fixed stop with sufficient pressure to attain full contact.
4. Install removable stops without displacing glazing spline. Exert pressure for full continuous contact.
5. Trim protruding tape edge.

3.4 FIELD QUALITY CONTROL

A. General Requirements: Quality requirements for testing and inspection services, and execution requirements for testing, adjusting and balancing.

B. Monitor quality of glazing.

3.5 MANUFACTURER'S FIELD SERVICES

A. General Requirements: Quality requirements for manufacturers’ field services.

B. Glass and glazing product manufacturers to provide field surveillance of installation.

C. Monitor and report installation procedures, and unacceptable conditions.

3.6 CLEANING

A. General Requirements: Execution requirements for final cleaning.

B. Remove glazing materials from finish surfaces.

C. Remove labels after Work is complete.

D. Clean glass and adjacent surfaces.

3.7 PROTECTION OF INSTALLED CONSTRUCTION

A. General Requirements: Execution requirements for protecting installed construction.

B. After installation, mark pane with an 'X' by using removable plastic tape or paste. Don’t mark heat absorbing or reflective glass units.

3.8 SCHEDULES

A. As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 09220

PORTLAND CEMENT PLASTER

PART 1 GENERAL

1.1 SUMMARY

A. Section includes Portland cement plaster system.

B. Related Sections:
1. Division 3 - Concrete.
2. Division 4 - Masonry.
3. Division 5 - Metals.
4. Division 8 - Doors and Windows.

1.2 REFERENCES

A. ASTM International:
1. ASTM C91 - Standard Specification for Masonry Cement.
2. ASTM C150 - Standard Specification for Portland Cement.
3. ASTM C206 - Standard Specification for Finishing Hydrated Lime.
4. ASTM C207 - Standard Specification for Hydrated Lime for Masonry Purposes.
5. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
6. ASTM C847 - Standard Specification for Metal Lath.
7. ASTM C897 - Standard Specification for Aggregate for Job-Mixed Portland Cement-Based Plasters.
8. ASTM C926 - Standard Specification for Application of Portland Cement-Based Plaster.
9. ASTM C932 - Standard Specification for Surface-Applied Bonding Agents for Exterior Plastering.
10. ASTM C933 - Standard Specification for Welded Wire Lath.
11. ASTM C979 - Standard Specification for Pigments for Integrally Colored Concrete.
12. ASTM C1002 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases.
13. ASTM C1032 - Standard Specification for Woven Wire Plaster Base.
14. ASTM C1063 - Standard Specification for Installation of Lathing and Furring to Receive Interior and Exterior Portland Cement-Based Plaster.
15. ASTM C1116 - Standard Specification for Fiber-Reinforced Concrete and Shotcrete.
16. ASTM C1328 - Standard Specification for Plastic (Stucco) Cement.
17. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.

B. Federal Specification Unit:
1. FS UU-B-790 - Building Paper, Vegetable Fiber: (Kraft, Waterproofed, Water Repellent and Fire Resistant).

C. National Terrazzo and Mosaic Association:
   1. NTMA - Terrazzo Specifications Guide.

D. Portland Cement Association:
   1. PCA - Portland Cement Plaster (Stucco) Manual.

E. Underwriters Laboratories Inc.:
   1. UL - Fire Resistance Directory.

F. Intertek Testing Services (Warnock Hersey Listed):
   1. WH - Certification Listings.

1.3 PERFORMANCE REQUIREMENTS

A. Conform to ASTM E119 and applicable code for fire rated assemblies, and as follows:
   1. Fire Rated Partitions: Listed assembly by UL or WH.
   2. Fire Rated Ceilings Bulkheads and Interior Soffits: Listed assembly by UL or WH.
   3. Fire Rated Structural Column Framing: Listed assembly by UL or WH.
   4. Fire Rated Structural Beam Framing: Listed assembly by UL or WH.

B. Fabricate vertical elements to limit finish surface to 1:360 deflection under lateral point load of 445 N.

C. Fabricate horizontal elements to limit finish surface to 1:360 deflection under superimposed dead load and wind uplift loads.

1.4 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

B. Product Data: Submit data on plaster materials, characteristics and limitations of products specified.

C. Samples: Submit two samples, size as directed, illustrating finish color and texture.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with ASTM C926 and PCA Portland Cement Plaster (Stucco) Manual.

B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum ten years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum five years documented experience.

1.7 MOCKUP

A. General Requirements: Quality requirements for mockup.

B. Construct mock-up, size as directed by the Engineer, including exterior and interior wall and ceiling system illustrating surface finish.

C. Locate where directed by the Engineer.

D. Remove mockup when directed by the Engineer.

1.8 PRE-INSTALLATION MEETINGS

A. General Requirements: Administrative requirements for pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.9 ENVIRONMENTAL REQUIREMENTS

A. General Requirements: Product requirements.

B. Exterior Plaster: Do not apply plaster when ambient temperature is less than 4ºC.

C. Interior Plaster: Do not apply cement plaster unless minimum temperature of 10ºC has been and continues to be maintained in building for minimum 48 hours prior to plaster application, during application, and until cured.

PART 2 PRODUCTS

2.1 PORTLAND CEMENT PLASTER

A. Manufacturer: Any internationally recognized manufacturer having an official technical agreement to conformity with standards for the product.

2.2 COMPONENTS:

A. Plaster Materials:
1. Cement: ASTM C150, Type I Portland cement.
2. Aggregate: Natural sand, within the following sieve sizes and percentage retained limits:

Sieve Size	Percent Retained
4.75 mm	0
2.36 mm	0 to 5
1.18 mm	5 to 30
0.60 mm	30 to 65
0.30 mm	65 to 95
0.15 mm	90 to 100

3. Water: Clean, fresh, potable and free of mineral or organic matter capable of affecting plaster.
4. Bonding Agent: ASTM C932; type recommended for bonding plaster to

concrete and concrete masonry surfaces.

5. Admixtures: Type as per manufacturer instructions.
6. Glass Fibers: 13 mm nominal length; meeting requirements of ASTM C1116.
7. Color Pigment: ASTM C979 mineral oxide or synthetic type, color as selected by the Engineer.
8. Sand for finish coats shall be clean, graded silica sand, 100% passing a 30 mesh screen.

B. Furring and Lathing:

1. Expanded Metal Lath: ASTM C847, galvanized, to suit application.
2. Woven Wire Plaster Base: ASTM C1032, having 25 mm openings.
3. Welded Wire Lath: ASTM C933.
4. Backing Material: FS UU-B-790 Grade D.
5. Casing and Corner Beads, and Base Screed: Formed sheet steel, depth governed by plaster thickness, maximum possible lengths, expanded metal or solid flanges, with square, bullnosed, or beveled edges; galvanized.
6. Corner Mesh: Formed sheet steel, minimum 0.5 mm thick, perforated or expanded flanges shaped to permit complete embedding in plaster, minimum 50 mm size; galvanized.
7. Strip Mesh: Expanded metal lath, minimum 0.5 mm thick, 50 mm wide x 600 mm long; galvanized.
8. Control and Expansion Joint Accessories: Formed sheet steel, accordion profile, 50 mm expanded metal or solid flanges each side, galvanized.
9. Anchorage: Tie wire, nails, and other metal supports, of type and size to suit application; to rigidly secure materials in place, galvanized.
10. Fasteners: ASTM C1002, self drilling, self tapping screws.
11. Polyethylene Sheet: Clear, 0.15 mm thick.
12. Access Panels in Plaster on Metal Furring (If Any): Formed stainless steel type 316, one hour fire rating.

C. Acoustic Accessories:

1. Resilient Channels: Formed steel, minimum 0.5 mm thick; face, profile and width as indicated on drawings, splicing permitted; galvanized.
2. Acoustic Insulation: ASTM C665, friction fit type, unfaced; Thickness as per manufacturer’s instructions.
3. Acoustic Sealant: Non-hardening, non-skinning, for use with plaster system.

2.3 MIXES

A. Except where hand-mixing of small batches is approved by the Engineer, mechanical mixers of an approved type shall be used for the mixing of plaster. Frozen, caked or lumped materials shall not be used.

B. Mechanical mixers, mixing boxes and tools shall be cleaned after mixing each batch and kept free of plaster from previous mixes. Plaster shall be thoroughly mixed with the proper amount of water uniform in colour and consistency. Retempering will not be permitted and all plaster which has begun to stiffen shall be discarded.

C. All tools, implements, vessels and surfaces shall at all time be kept scrupulously clean and strict precautions shall be taken to avoid the plasterer or other materials becoming contaminated by pieces of partially set material which would tend to retard or

accelerate the setting time.

D. Spartterdash Coat (Rasheh): 1 part Portland cement and maximum 2 parts of sand, proportioned by volume.

E. Internal plaster shall be (1:4) composed of 350 kg of cement per m^3 of sand. Internal plaster shall be 15 mm thick for walls and ceilings.

F. External plaster shall be (1:3) composed of 475 kg of cement per m^3 of sand. External plaster shall be 20 mm thick.

G. Internal and external plasters shall be executed in one single coat work in addition to the spartterdash (Rasheh). If more than one coat is required, approved galvanized wire mesh reinforcement shall be used.

H. Mix and proportion cement plaster in accordance with approved methodology.

I. Add glass fibers to plaster at rate of 8.0 kg per cubic meter of plaster.

J. Add admixtures as instructed by the manufacturer.

K. Mix only as much plaster as can be used prior to initial set.

L. Add color pigments to finish coat.

M. Mix materials dry, to uniform color and consistency, before adding water.

N. Protect mixtures from freezing, frost, contamination, and excessive evaporation.

O. Do not retemper mixes after initial set has occurred.

2.4 READY MIX PLASTER

A. For External Applications: Fiber reinforced cementitious ready mix plaster as produced by "Sodamco" or similar approved.
1. Appearance: Grey powder.
2. Grain Size: 0.02 to 1.5 mm.
3. Composition: Portland cement, selected sand, fibers and additives.
4. Wet Mix Life: Less than 1 hour.
5. Compressive Strength: 10 MPa.
6. Mix: 50 kg bag with 9 to 10 liters of clean water.
7. Coat Thickness: 15 mm.
8. Consumption: Around 2.0 kg/m^2/1mm thickness.

B. For Internal Applications: Cementitious ready mix plaster as produced by "Sodamco" or similar approved.
1. Appearance: Grey powder.
2. Grain Size: 0.02 to 1.5 mm.
3. Composition: Portland cement, selected sand and additives.
4. Wet Mix Life: Less than 1 hour.
5. Mix: 50 kg bag with 7 to 8 liters of clean water.

6. Coat Thickness: 15 mm.
7. Consumption: Around 1.7 kg/m²/1mm thickness.

PART 3 EXECUTION

3.1 EXAMINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Masonry: Verify joints are cut flush and surface is ready to receive work of this section. Verify no bituminous or water repellent coatings exist on masonry surface.

C. Concrete: Verify surfaces are flat, honeycomb and are filled flush, and surfaces are ready to receive work of this section. Verify no bituminous, water repellent, or form release agents exist on concrete surface that are detrimental to plaster bond.

D. Metal Lath and Accessories: Verify lath is flat, secured to substrate, and joint and surface perimeter accessories are in place.

E. Mechanical and Electrical: Verify services within surfaces to be plastered (walls, ceiling, etc.) have been tested and approved.

3.2 PREPARATION

A. Dampen masonry surfaces to reduce excessive suction.

B. Clean concrete surfaces of foreign matter. Clean surfaces using acid solutions, solvents, or detergents. Wash surfaces with clean water.

C. Roughen smooth concrete surfaces and apply bonding agent.

D. Galvanized wiremesh reinforcement shall be provided wherever blockwalls abut against concrete columns, beams or slabs, and plaster finish is required to continue over both blockwork and concrete surfaces. The galvanized wiremesh reinforcement shall consist of 20 cm wide strips and shall cover the whole length of the joint, horizontally as well as vertically and shall be securely nailed, plugged or stapled in place to both surfaces at intervals not exceeding 40 cm at both edges.

E. Plastering shall not be commenced until all mechanical and electrical services, conduits, pipes and fixtures have been installed complete and tested.

F. All walls shall be wetted immediately prior to applying the first spatterdash coat (Rasheh) to provide key for subsequent coats.

3.3 EXISTING WORK

A. Extend existing Portland cement plaster installations using materials and methods as specified.

B. Repair existing damaged Portland cement plaster which remains or to be remodeled.

3.4 INSTALLATION

A. Installation of Lathing Materials:
1. Apply one or two layers of Grade D building paper over substrate; lap edges 50 mm minimum. Fasten in place.
2. Install metal lath in accordance with ASTM C1063.

B. Installation of Accessories:
1. Install accessories in accordance with ASTM C1063.
2. Place corner bead at external wall corners; fasten at outer edges of lath only.
3. Place strip mesh diagonally at corners of lathed openings. Secure rigidly in place.
4. Place casing beads at terminations of plaster finish. Butt and align ends. Secure rigidly in place.
5. Install door and glazed frames plumb and level in opening. Secure rigidly in place.
6. Position to provide convenient access to concealed work requiring access.

C. Control and Expansion Joints:
1. Install interior control and expansion joints as indicated on Drawings.
2. Install exterior contraction joints after initial set, scribed as indicated on Drawings by cutting through 2/3 of cement plaster depth, neatly, in straight lines.
3. For horizontal exterior surfaces, install control and expansion joints as indicated on Drawings.
4. For vertical exterior surfaces install control and expansion joints as indicated on Drawings.
5. Establish control and expansion joints with specified joint device.

D. Plastering:
1. Plaster shall be thoroughly mixed with the proper amount of water until uniform in colour and consistency. Retempering will not be permitted and all plaster which has begun to stiffen shall be discarded.
2. All plastering shall be executed in a neat workmanlike manner and corners shall be true, straight and plumb.
3. All tools, implements, vessels and surfaces shall at all times be kept scrupulously clean and strict precautions shall be taken to avoid the plaster or other materials becoming contaminated by pieces of partially set materials which would tend to retard or accelerate the setting time.
4. The temperature before, during and after application of plaster shall be uniformly maintained above 12°C. The heat shall be well distributed in all areas, and concentration or irregular heat on plaster surfaces shall be prevented.
5. Ventilation shall be provided to properly dry the plaster during and subsequent to its application. Plaster shall be prevented from too-rapid drying.
6. All ingredients entering the several mixes shall be proportioned and measured

by means of calibrated boxes or containers of such nature that the quantities can be accurately checked at any time. Ingredients shall be thoroughly mixed and then cleaned from the mixer and tools after each mix.

7. Plaster shall be rodded and straight-edged to uniform thickness in true planes flush to the required surface and flush with outlet boxes, and similar details and steel-troweled smooth and level with sharp, straight arises and true angles. Plaster shall be free from laps, cracks, trowels marks, or other structural defects or surface imperfections.
8. Where plaster finish is flush with adjoining surface or where tooled joint is indicated on the drawings, the plaster shall be grooved back with smallest available edging tool, to control any cracking at these points.
9. At doors and frames and other openings, all plaster shall be keyed in, except that across head of openings and 12 inches down each side plaster shall be cut free of frame, or grounds with edge of trowel, after stiffening but before setting, to allow for expansion.
10. All pressed metal door frames in walls shall be grouted full with Portland cement fine concrete after being completely anchored in place and prior to application of plaster. Rake grout to allow plaster to enter jamb.
11. Apply the spatterdash coat (Rasheh) and allow to dry before rendering is commenced.
12. Moist cure each coat. Apply successive coat immediately following initial set of scratch coat.
13. After curing, dampen previous coat prior to applying finish coat.
14. Apply finish coat to indicated color and texture.
15. Plumb, square and level.
16. Avoid excessive working of surface. Delay troweling as long as possible to avoid drawing excess fines to surface.
17. Moist cure finish coat for minimum period of 48 hours.

E. Waterproof Plaster to External Surfaces:

1. All surfaces to be plastered shall be clean and free from dust, grease, loose or projecting mortar and all traces of salts and are to be thoroughly sprayed with water but all free water shall be allowed to disappear from the surface before the plaster is applied.
2. Efflorescence shall be brushed off and all dust and foreign matter removed. All waterproof plastering shall be in two coats and shall contain 475 kg of cement per one meter cube of sand mixed with an approved waterproofing admixture compound and applied in accordance with manufacturer’s instructions and shall be applied and allowed to dry before rendering is commenced. All walls shall be wetted immediately prior to applying the first coat of rendering and this shall be allowed to thoroughly dry out before the next coat is applied.

3.5 ERECTION TOLERANCES

A. General Requirements: Quality requirements for tolerances.

B. Maximum Variation from Flat Surface: 3 mm in 3 m.

3.6 ADJUSTING

A. General Requirements: Execution requirements for testing, adjusting and balancing.

B. Remove damaged or defective plaster by cutting and replace with specified materials to match adjacent plaster.

C. Fog coat non-uniform or discolored plaster with finish coat materials spray applied to entire finish coat surface.

3.7 SCHEDULES

A. As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 09260

GYPSUM BOARD ASSEMBLIES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes metal stud wall framing; metal channel ceiling framing; shaft wall system; gypsum board and joint treatment; acoustic insulation; and textured finish.

B. Related Sections:
1. Division 5 - Metals.
2. Division 6 - Wood and Plastics.
3. Section 07212 - Board Insulation.
4. Section 08310 - Access Doors and Panels.

1.2 REFERENCES

A. ASTM International:
1. ASTM C36 - Standard Specification for Gypsum Wallboard.
2. ASTM C79/C79M - Standard Specification for Gypsum Sheathing Board.
3. ASTM C442 - Standard Specification for Gypsum Backing Board and Coreboard.
4. ASTM C475 - Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
5. ASTM C514 - Standard Specification for Nails for the Application of Gypsum Board.
6. ASTM C557 - Standard Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing.
7. ASTM C630/C630M - Standard Specification for Water-Resistant Gypsum Backing Board.
8. ASTM C645 - Standard Specification for Nonstructural Steel Framing Members.
9. ASTM C665 - Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
10. ASTM C754 - Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
11. ASTM C840 - Standard Specification for Application and Finishing of Gypsum Board.
12. ASTM C931/C931M - Standard Specification for Exterior Gypsum Soffit Board.
13. ASTM C1002 - Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases.
14. ASTM C1280 - Standard Specification for Application of Gypsum Sheathing.
15. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
16. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.

B. Gypsum Association:
   1. GA 214 - Recommended Levels of Gypsum Board Finish.
   2. GA 216 - Application and Finishing of Gypsum Board.
   3. GA 600 - Fire Resistance Design Manual Sound Control.

C. Underwriters Laboratories Inc.:
   1. UL - Fire Resistance Directory.

D. Intertek Testing Services (Warnock Hersey Listed):
   1. WH - Certification Listings.

1.3 PERFORMANCE REQUIREMENTS

A. Conform to applicable code for fire rated assemblies and as follows:
   1. Fire Rated Partitions: Listed assembly by UL or WH or GA File.
   2. Fire Rated Ceiling and Soffits: Listed assembly by UL or WH or GA File.
   3. Fire Rated Structural Column Framing: Listed assembly by UL or WH or GA File.
   4. Fire Rated Structural Beam Framing: Listed assembly by UL or WH or GA File.
   5. Fire Rated Shaft Wall Requirements: in accordance with UL or WH listed assembly or GA File.

B. Acoustic Attenuation for Interior Partitions: STC in accordance with ASTM E90.

C. Shaft Wall: Perform to the following:
   1. Air Pressure within Shaft: and maximum mid-span deflection as per applicable code.
   2. Acoustic Attenuation: STC in accordance with ASTM E90.

1.4 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

B. Shop Drawings: Indicate special details associated with fireproofing and acoustic seals.

C. Product Data: Submit data on metal framing, gypsum board, joint; decorative finish, and acoustic accessories.

D. Samples: Submit two samples of each type of gypsum board, size 300 x 300 mm, illustrating finish color and texture.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with ASTM C840, ASTM C1280, GA-214, GA-216 and GA-600.

B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum ten years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum five years documented experience.

1.7 MOCKUP

A. General Requirements: Quality requirements for mockup.

B. Construct mock-up, size as directed by the Engineer, including interior wall and ceiling system illustrating surface finish.

C. Locate where directed by the Engineer.

D. Remove mockup when directed by the Engineer.

1.8 PRE-INSTALLATION MEETINGS

A. General Requirements: Administrative requirements for pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE AND HANDLING

A. Deliver materials in original packages, containers or bundles bearing brand name and identification of manufacturer or supplier.

B. Store materials under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic and other causes. Neatly stack gypsum boards flat to prevent sagging. Store channels and studs to avoid damage.

C. Handle gypsum boards to prevent damage to edges, ends and surfaces. Do not bend or otherwise damage metal corner beads and trim.

1.10 PROJECT CONDITIONS

A. Monitor environmental conditions for application and finishing Gypsum Wallboard Systems to comply with Gypsum Waldboard Systems manufacturer’s recommendations.

B. For non adhesive attachment of gypsum board to framing, maintain temperature no less than 4.4 degrees C. For adhesive attachment and finishing of gypsum board, maintain temperature no less than 10 degrees C for 48 hours prior to application and continuously thereafter until adhesive is dry.

C. Ventilate building spaces to remove water not required for drying joint treatment materials. Avoid drafts during dry, hot weather to prevent materials from drying too rapidly.

PART 2 PRODUCTS

2.1 GYPSUM BOARD ASSEMBLIES

A. Manufacturer: Any internationally recognized manufacturer having an official technical agreement to conformity with standards for the product.

2.2 COMPONENTS

A. Framing Materials:
1. Studs and Tracks: ASTM C645; GA-216 and GA-600; galvanized sheet steel, thickness and shape as indicated on drawings.
2. Shaft Wall Studs and Accessories: As instructed by the manufacturer.
3. Furring, Framing, and Accessories: ASTM C645, GA-216 and GA-600.
4. Fasteners: ASTM C514, ASTM C1002, and GA-216.
5. Anchorage to Substrate: Tie wire, nails, screws, and other metal supports, of type and size to suit application; to rigidly secure materials in place.
6. Adhesive: ASTM C557, and GA-216.

B. Gypsum Board Materials:
1. Standard Gypsum Board: ASTM C36; 12 mm thick; ends square cut, tapered, beveled, square or round edges.
2. Fire Rated Gypsum Board: ASTM C36; fire resistive type, UL or WH rated; 12 mm thick; ends square cut, tapered, beveled, square or round edges.
3. Moisture Resistant Gypsum Board: ASTM C630/C630M; 12 mm thick; ends square cut, tapered, beveled, square, or round edges.
4. Exterior Gypsum Soffit Board: ASTM C931/C931M; standard or fire rated type, 12 mm thick; ends square cut, tapered, beveled, square, or round edges.
5. Gypsum Backing Board: ASTM C442; standard, fire rated or insulating type; 12 mm thick; square, round, V-grooved, or book tongue and grooved edges, ends square cut.
6. Length or Size: Maximum available length or size in place.
7. Batten Joints: Manufacturer's standard type.

2.3 ACCESSORIES

A. Acoustic Insulation: ASTM C665; preformed glass fiber, friction fit type, un-faced, thickness as instructed by the manufacturer.

B. Acoustic Sealant: Non-hardening, non-skinning, for use in conjunction with gypsum board.

C. Corner Beads: Metal and/or Metal and paper combination.

D. Edge Trim: GA-216; Type LC, L, LK and/or U exposed reveal bead.

E. Joint Materials: ASTM C475; GA-216; reinforcing tape, joint compound, adhesive, and water.

F. Textured Finish Materials: As indicated on drawings.

G. Fasteners: ASTM C1002, Type S12 or W, and GA-216.

PART 3 EXECUTION

3.1 EXAMINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Verify site conditions are ready to receive work and opening dimensions are as indicated on shop drawings and as instructed by manufacturer.

3.2 EXISTING WORK

A. Extend existing installations of gypsum board using materials and methods as specified.

B. Repair and remodel existing gypsum board assemblies which remain or are to be altered.

3.3 INSTALLATION

A. Metal Stud Installation:
1. Install studs in accordance with ASTM C754, GA-216 and GA-600.
2. Metal Stud Spacing: 600 mm on center.
3. Extend stud framing to ceiling only. Attach ceiling runner securely to acoustic ceiling track or ceiling framing, in accordance with details indicated.
4. Refer to Drawings for indication of partitions extending stud framing through ceiling to structure above. Maintain clearance under structural building members to avoid deflection transfer to studs. Provide extended leg ceiling runners.
5. Door Opening Framing: Install double studs at door frame jambs. Install stud tracks on each side of opening, at frame head height, and between studs and adjacent studs.
6. Blocking: Nail wood blocking to studs, or Bolt or screw steel channels to studs. Install blocking for support of plumbing fixtures, toilet partitions, wall cabinets, wood frame opening, toilet accessories, and/or hardware.

B. Wall Furring Installation:
1. Erect wall furring for direct attachment to concrete masonry and concrete walls.
2. Erect furring channels horizontally and/or vertically; space maximum 600 mm oc, not more than 100 mm from floor and ceiling lines. Secure in place on alternate channel flanges at maximum 600 mm on center.
3. Install thermal insulation in conjunction with Section 07212 directly attached to concrete masonry and concrete walls.
4. Erect metal stud framing tight to concrete and/or concrete masonry walls, attached by adjustable furring brackets.

C. Furring for Fire Ratings: Install furring as required for fire resistance ratings indicated and to GA-600 requirements.

D. Shaft Wall Framing: To GA-600 requirements.

E. Ceiling Framing Installation:
1. Install in accordance with ASTM C754 and GA-216.
2. Coordinate location of hangers with other work.
3. Install ceiling framing independent of walls, columns, and above ceiling work.
4. Reinforce openings in ceiling suspension system which interrupt main carrying channels or furring channels, with lateral channel bracing. Extend bracing minimum 600 mm past each end of openings.
5. Laterally brace entire suspension system.

F. Acoustic Accessories Installation:
1. Install resilient channels at maximum 600 mm on center. Locate joints over framing members.
2. Place acoustic insulation in 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.
3. Install acoustic sealant within partitions or at gypsum board perimeter at:
   a. Metal Framing: Two beads.
   b. Base Layer.
   c. Face Layer.
   d. Seal penetrations of partitions by conduit, pipe, duct work, and rough-in ` boxes.

G. Gypsum Board Installation:
1. Install gypsum board in accordance with GA-216 and GA-600.
2. Erect single layer standard gypsum board in most economical direction, with ends and edges occurring over firm bearing.
3. Erect single layer fire rated gypsum board vertically, with edges and ends occurring over firm bearing.
4. Erect exterior gypsum soffit board in accordance with ASTM C931/C931M.
5. Use screws when fastening gypsum board to metal furring or framing.
6. Use nails or screws when fastening gypsum board to wood furring or framing. Staples may only be used when securing first layer of double layer applications.
7. Double Layer Applications: Secure second layer to first with fasteners or adhesive and sufficient support to hold in place. Use fire rated gypsum backing board for fire rated partitions and ceilings. Place second layer perpendicular or parallel to first layer as indicated on drawings. Offset joints of second layer from joints of first layer.
8. Erect exterior gypsum soffit board perpendicular to supports, with staggered end joints over supports.
9. Treat cut edges and holes in moisture resistant gypsum board and exterior gypsum soffit board with sealant.
10. Place control joints consistent with lines of building spaces as indicated on Drawings and/or as directed.
11. Place corner beads at external corners as indicated on Drawings. Use longest practical length. Place edge trim where gypsum board abuts dissimilar materials as indicated on Drawings.
12. Apply gypsum board to curved walls in accordance with GA-216.

H. Joint Treatment:
   1. Tape, fill, and sand exposed joints, edges, and corners to produce smooth surface ready to receive finishes.
   2. Feather coats on to adjoining surfaces so that camber is maximum 0.8 mm.
   3. Taping, filling, and sanding is not required at surfaces behind adhesive applied ceramic tile.

I. Texture Finish: Spray, Trowel, Roller and/or Brush apply finish texture coating.

J. Install Work in accordance with the drawings, to the manufacturer's instructions, and to the approval of the Engineer.

3.4 ERECTION TOLERANCES

A. General Requirements: Quality requirements for tolerances.

B. Maximum Variation of Finished Gypsum Board Surface from Flat Surface: 3mm/3m.

3.5 SCHEDULES

A. As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 09300

TILE

PART 1 GENERAL

1.1 SUMMARY

A. Section includes ceramic, ceramic mosaic, quarry, and paver, tile for floor and for wall applications; tile stair treads and risers using mortar bed and backing application method; cementitious backer board as tile substrate; thresholds at door openings; and tile accessories.

B. Related Sections:
1. Section 03350 - Concrete Finishes.
2. Section 07130 - Waterproofing membrane.
3. Section 07140 - Fluid Applied Waterproofing.
4. Section 07900 - Joint Sealers.
5. Section 09220 - Portland Cement Plaster.
6. Section 10800 - Toilet, Bath and Laundry Accessories
7. Division 15 - Mechanical: Plumbing Fixtures.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI A108.1 - Installation of Ceramic Tile, A collection.
2. ANSI A108.10 - Specifications for Installation of Grout in Tilework.
3. ANSI A108.1A - Specifications for Installation of Ceramic Tile in the Wet-Set Method with Portland Cement Mortar.
4. ANSI A108.1B - Specifications for Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex Portland Cement Mortar.
5. ANSI A108.1C - Specifications for Contractors Option: Installation of Ceramic Tile in the Wet-Set Method with Portland Cement Mortar -or- Installation of Ceramic Tile on a Cured Portland Cement Mortar Setting Bed with Dry-Set or Latex Portland Cement Mortar.
6. ANSI A108.4 - Specifications for Ceramic Tile Installed with Organic Adhesives or Water-Cleanable Tile Setting Epoxy Adhesive.
7. ANSI A108.5 - Specifications for Ceramic Tile Installed with Dry-Set Portland Cement Mortar or Latex-Portland Cement Mortar.
8. ANSI A108.6 - Specifications for Ceramic Tile Installed with Chemical-Resistant, Water-Cleanable Tile-Setting and -Grouting Epoxy.
9. ANSI A108.7 - Specifications for Electrically Conductive Ceramic Tile Installed with Conductive Dry-Set Portland Cement Mortar.
10. ANSI A108.8 - Specifications for Ceramic Tile Installed with Chemical-Resistant Furan Mortar and Grout.
11. ANSI A108.9 - Specifications for Ceramic Tile Installed with Modified Epoxy Emulsion Mortar/Grout.
12. ANSI A118.1 - Standard Specification for Dry-Set Portland Cement Mortar.
13. ANSI A118.3 - Chemical-Resistant, Water-Cleanable, Tile-Setting and -

Grouting Epoxy and Water-Cleanable Tile-Setting Epoxy Adhesive.

14. ANSI A118.4 - Latex-Portland Cement Mortar.
15. ANSI A118.5 - Chemical-Resistant Furan Mortar and Grout.
16. ANSI A118.6 - Ceramic Tile Grouts.
17. ANSI A118.8 - Modified Epoxy Emulsion Mortar/Grout.
18. ANSI A118.9 - Test Methods and Specifications for Cementitious Backer Units.
19. ANSI A136.1 - Organic Adhesives for Installation of Ceramic Tile.
20. ANSI A137.1 - Ceramic Tile.

B. ASTM International:
1. ASTM C847 - Standard Specification for Metal Lath.

C. Tile Council of America:
1. TCA - Handbook for Ceramic Tile Installation.

1.3 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

A. Shop Drawings: Indicate tile layout, patterns, color arrangement, perimeter conditions, junctions with dissimilar materials, control and expansion joints, thresholds, ceramic accessories, and setting details.

C. Product Data: Submit instructions for using grouts and adhesives.

D. Samples: Submit for each type of tile and grout required, two samples on two plywood panels backing, 300 x 300 mm each, illustrating pattern, color variations, and grout type, color and joint size variations.

E. Samples: Submit two samples for each type of tile and grout required, 300 x 300 mm wood panels backing, illustrating pattern, color variations, and grout type and joint size variations.

F. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

A. General Requirements: Execution requirements for closeout procedures.

B. Operation and Maintenance Data: Submit recommended cleaning methods, cleaning materials, stain removal methods, and polishes and waxes.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with TCA Handbook and ANSI A108 Series/A118 Series.

B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this

section with minimum ten years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum five years documented experience.

1.7 MOCKUP

A. General Requirements: Quality requirements for mockup.

B. Construct mock-up, size as directed by the Engineer, with backer board, cleavage membrane, waterproofing, finish grout, and specified accessories.

C. Locate where directed by the Engineer.

D. Remove mockup when directed by the Engineer.

1.8 PRE-INSTALLATION MEETINGS

A. General Requirements: Administrative requirements for pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE AND HANDLING

A. General Requirements: Product requirements for product storage and handling.

B. Protect adhesives and grouts from freezing or overheating.

1.10 ENVIRONMENTAL REQUIREMENTS

A. General Requirements: Product requirements.

B. Do not install adhesives and grouts in unventilated environment.

C. Maintain ambient and substrate temperature of 10 ºC during installation of mortar materials.

1.11 EXTRA MATERIALS

A. General Requirements: Execution requirements for spare parts and maintenance products.

B. Supply 10 sq m of each type, size, color and surface finish of tile specified.

PART 2 PRODUCTS

2.1 TILE

A. Manufacturer: Any internationally recognized manufacturer having an official technical agreement to conformity with standards for the product.

2.2 COMPONENTS

A. Ceramic and Mosaic Tile: ANSI A137.1, and conforming to the following:
   1. Moisture Absorption: 0 to 0.5 percent.
   2. Size: As indicated on drawings.
   3. Shape: Square or rectangular, as indicated on drawings.
   4. Edge: Square or cushioned, as indicated on drawings.
   5. Surface Finish: Unglazed, matte glazed, mottle glazed, or slip resistant, as indicated on drawings.
   6. Color: As selected.
   7. Mounted Sheet Size: As indicated on drawings.

B. Ceramic Wall Tile: ANSI A137.1, and conforming to the following:
   1. Moisture Absorption: 0 to 0.5 percent.
   2. Size: As indicated on drawings.
   3. Shape: Square or rectangular, as indicated on drawings.
   4. Edge: Square or cushioned, as indicated on drawings.
   5. Surface Finish: Unglazed, matte or mottle glazed, as indicated on drawings.
   6. Color: As selected.
   7. Pattern: As indicated on drawings.

C. Quarry Tile: ANSI A137.1, and conforming to the following:
   1. Moisture Absorption: 0 to 0.5 percent.
   2. Size: As indicated on drawings.
   3. Shape: Square or rectangular, as indicated on drawings.
   4. Edge: Square or cushioned, as indicated on drawings.
   5. Surface Finish: Unglazed, matte glazed or non-slip, as indicated on drawings.
   6. Color: As selected.

D. Paver Tile: ANSI A137.1, and conforming to the following:
   1. Moisture Absorption: 0 to 0.5 percent.
   2. Size: As indicated on drawings.
   3. Shape: Square or rectangular, as indicated on drawings.
   4. Edge: Square or cushioned, as indicated on drawings.
   5. Surface Finish: Unglazed, matte glazed or non-slip, as indicated on drawings.
   6. Color: As selected.

E. Skirting or Base: To match floor tile for moisture absorption, surface type and finish, and color:
   1. Length: Tile length: As indicated on drawings.
   2. Height: As indicated on drawings.
   3. Top Edge: Bull nosed, unless otherwise indicated.
   4. Internal Corner: Coved, unless otherwise indicated.
   5. External Corner: Bullnosed, unless otherwise indicated.
   6. Moisture Absorption: 0 to 0.5 percent.
   7. Surface Finish: Unglazed, matte or mottle glazed, as indicated on drawings.
   8. Color: As selected.

F. Wainscot Cap: Match mosaic wall tile for moisture absorption, surface finish, and color, tile length and height as indicated on drawings, bull nosed top edge, unless otherwise indicated.

G. Stair Tread and Riser: Match quarry tile and paver tile for moisture absorption, surface finish, and color:
   1. Tread Length and Width: As indicated on drawings.
   2. Riser Length and Height: As indicated on drawings.
   3. Nosing: Radiused or bull nosed, as indicated on drawings.
   4. Tread Surface: Non-slip or ribbed, as indicated on drawings.

2.3 ACCESSORIES

A. Ceramic Accessories: Glazed and unglazed finish, size as indicated on drawings; same color and texture as adjacent wall tile.

B. Adhesive Materials:
   1. Organic Adhesive: ANSI A136.1, thin-set bond type.
   2. Epoxy Adhesive: ANSI A118.3, thin-set bond type.
   3. Tile Setting Adhesive: Elastomeric, waterproof, and liquid applied.

C. Mortar Materials:
   1. Mortar Bed Materials: Portland cement, sand, latex additive and water.
   2. Mortar Bond Coat Materials:
      a. Dry-Set Portland Cement type: ANSI A118.1.
      b. Latex-Portland Cement type: ANSI A118.4.
      c. Epoxy: ANSI A118.3.
      d. Furan: ANSI A118.5.

D. Grout Materials:
   1. Standard Grout: Portland cement type, Sand-Portland Cement type, Latex-Portland cement type, or Silicone Rubber type as specified in ANSI A118.6.
      a. Color Admixture: Site mixed type as recommended by manufacturer.
      b. Color: As selected.
   2. Epoxy Grout: ANSI A118.8, modified epoxy emulsion grout, color as selected.
   3. Furan Grout: ANSI A118.5, furan resin type, color as selected.
   4. Silicone Rubber Grout: Silicone sealant, moisture and mildew resistant type, complying with ANSI A118.6, color as selected; use for wet floors and walls.

E. Cleavage Membrane: 6.9 kg asphalt saturated felt or 0.1 mm thick polyethylene film.

F. Waterproofing Membrane at Floors: As per Section 07130 or Section 07140.

G. Membrane at Walls: 6.9 kg asphalt saturated felt or 0.1 mm thick polyethylene film.

H. Reinforcing Mesh: 50 x 50 mm size weave of 16/16 wire size; welded fabric, galvanized.

I. Metal Lath: ASTM C847, Flat diamond mesh, of weight to suit application, galvanized finish

J. Cementitious Backer Board: ANSI A118.9; High density, cementitious, glass fiber reinforced, 13 mm thick; 50 mm wide coated glass fiber tape for joints and corners.

K. Thresholds: Marble type, color and finish as indicated on drawings, size by full width of wall or frame opening, beveled both sides, radiused edges from bevel to vertical face.

L. Toilet and Bath Accessories: Refer to Section 10800.

PART 3 EXECUTION

3.1 EXAMINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Verify surfaces are ready to receive work.

3.2 PREPARATION

A. Protect surrounding work from damage.

B. Vacuum clean surfaces and damp clean.

C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.

D. Install cementitious backer board. Tape joints and corners, cover with skim coat of dry-set mortar to feather edge.

E. Prepare substrate surfaces for adhesive installation.

3.3 EXISTING WORK

A. General Requirements: Execution requirements for maintenance service.

B. Prepare and remodel existing tile installations using materials and methods as specified.

C. Clean and repair existing tile which remains.

3.4 INSTALLATION

A. Install tile, skirting, thresholds, stair treads and risers, and grout in accordance with applicable requirements of ANSI A108.1 through A108.10, and TCA Handbook recommendations.

B. Lay tile to pattern indicated. Do not interrupt tile pattern through openings.

C. Place thresholds and edge strips at locations indicated and/or scheduled.

D. Cut and fit tile to penetrations through tile, leaving sealant joint space. Form corners and bases neatly. Align floor, base and wall joints.

E. Place tile with joints uniform in width, subject to variance in tolerance allowed in tile size. Make joints watertight, without voids, cracks, excess mortar, or excess grout.
   1. Ceramic and Ceramic Mosaic Tile: 1.6 and 3 mm.
   2. Quarry and Paver Tile: 6 and 10 mm.

F. Form internal angles square or coved and external angles bullnosed or square, unless otherwise indicated.

G. Install ceramic accessories rigidly in prepared openings.

H. Sound tile after setting. Replace hollow sounding units.

I. Keep expansion and control joints free of adhesive or grout. Apply sealant to joints.

J. Allow tile to set for a minimum of 48 hours prior to grouting.

K. Grout tile joints. Use standard grout unless otherwise indicated.

L. Apply sealant to junction of tile and dissimilar materials and junction of dissimilar planes.

M. Installation - Floors - Thin-Set Methods:
1. Over exterior concrete substrates, install in accordance with TCA Handbook Method F102, with standard grout.
2. Over interior concrete substrates, install in accordance with TCA Handbook Method F113, dry-set or latex-Portland cement bond coat or F116, organic adhesive, with standard grout, unless otherwise indicated.
   a. Where waterproofing membrane is indicated, install in accordance with TCA Handbook Method F122, with latex-Portland cement grout.
   b. Where epoxy bond coat and grout are indicated, install in accordance with TCA Handbook Method F131.
   c. Where furan bond coat and grout are indicated, install in accordance with TCA Handbook Method F133.
   d. Where epoxy or furan grout is indicated, but not epoxy or furan bond coat, install in accordance with TCA Handbook Method F115.
3. Over wood substrates, install in accordance with TCA Handbook Method F142, with standard grout, unless otherwise indicated.
   a. Where epoxy bond coat and grout are indicated, install in accordance with TCA Handbook Method F143.

N. Installation - Floors - Mortar Bed Methods:
1. Over exterior concrete substrates, install in accordance with TCA F101, bonded, with standard grout.
2. Over interior concrete substrates, install in accordance with TCA Handbook Method F111, with cleavage membrane and/or F112, bonded, unless otherwise indicated.
   a. Where waterproofing membrane is indicated, with standard grout or no mention of grout type, install in accordance with TCA Handbook Method F121.
   b. Where epoxy bond coat and grout are indicated, install in accordance with TCA Handbook Method F132, bonded.
   c. Where conductive tile are indicated, install in accordance with TCA Handbook Method F125, bonded.
   d. Where epoxy or furan grout is indicated, but not epoxy or furan bond coat, install in accordance with TCA Handbook Method F114, with

or without cleavage or waterproofing membrane.

3. Over wood substrates, install in accordance with TCA Handbook method F141, with standard grout, unless otherwise indicated.
4. Cleavage Membrane: Lap and seal watertight, edges and ends.
5. Waterproofing Membrane: Install as per Section 07130 or Section 07140.
6. Mortar Bed Thickness: 15 mm, unless otherwise indicated.

O. Installation - Showers and Bathtub Walls:

1. At tiled shower receptors install in accordance with TCA Handbook Method B414, mortar bed floor, and W201, mortar bed over concrete or masonry walls or B415, mortar bed floor, and W244, thin-set over cementitious backer unit walls.
2. At bathtub walls install in accordance with TCA Handbook Method B411, mortar bed on studs with waterproofing membrane; B412, over cementitious backer units with waterproofing membrane; or W202, thin-set over masonry.
3. Grout with silicone rubber grout.
4. Seal joints between tile work and other work with sealant Type specified in Section 07900.

P. Installation - Wall Tile:

1. On exterior walls install in accordance with TCA Handbook Method W244, thin-set over cementitious backer units with waterproofing membrane, W201, mortar bed over concrete and masonry with waterproofing membrane, or W202, thin-set over concrete and masonry with latex-Portland cement grout.
2. Over cementitious backer units install in accordance with TCA Handbook Method W244, using membrane at toilet rooms and kitchens; or W223, organic adhesive.
3. Over gypsum wallboard or wood or metal studs install in accordance with TCA Handbook Method W243, thin-set with dry-set or latex-Portland cement bond coat, W223, thin-set with organic adhesive, unless otherwise indicated.
   a. Where mortar bed is indicated, install in accordance with TCA Handbook Method W222, one coat method.
   b. Where waterproofing membrane is indicated other than at showers and bathtub walls, install in accordance with TCA Handbook Method W222, one coat method.
4. Over interior concrete and masonry install in accordance with TCA Handbook Method W202, thin-set with dry-set or latex-Portland cement bond coat, or W211, bonded mortar bed without membrane.
5. Over wood studs without backer install in accordance with TCA Handbook Method W231, mortar bed, with membrane where indicated.
6. Over metal studs without backer install in accordance with TCA Handbook Method W241, mortar bed, with membrane where indicated.

3.5 CLEANING

A. General Requirements: Execution requirements for final cleaning.

B. Clean tile and grout surfaces.

3.6 PROTECTION OF INSTALLED CONSTRUCTION

A. General Requirements: Execution requirements for protecting installed construction.

B. Do not permit traffic over finished floor surface for 4 days after installation.

3.7 SCHEDULES

A. As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 09510

ACOUSTICAL METAL PAN CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes clip-in acoustical aluminium pans and the following suspension system for ceilings:-
   1. Indirect-hung, concealed grid designed to support metal pans.

B. Related Sections:-
   1. Division 5 Section "Metal Fabrications”.
   2. Division 9 Section “Gypsum board”.
   3. Divisions 15 and 16 Sections for light fixtures, sprinklers, and air-distribution components.

1.3 DEFINITIONS

A. CAC: Ceiling Attenuation Class.

B. LR: Light Reflectance coefficient.

C. NRC: Noise Reduction Coefficient.

1.4 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1.5 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Initial Selection: For components with factory-applied color and other decorative finishes.

C. Samples for Verification: For each component indicated and for each exposed finish required, prepared on Samples of size indicated below:
   1. Metal Pans: Set of full-size square Samples of each type, finish, color, pattern, and texture. Show pan edge profile.

2. Suspension System Members, Moldings and Trim: Set of 300-mm- long Samples of each type, finish, and color.
3. Sound Absorber: Match size of Sample metal pan.

D. Performance Data: For installed products indicated to comply with design loads and other criteria, include structural analysis and other analytical data signed and sealed by the qualified professional engineer responsible for their preparation.

E. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
1. Ceiling suspension members.
2. Method of attaching hangers to building structure.
   a. Furnish layouts for cast-in-place anchors, clips, and other ceiling attachment devices whose installation is specified in other Sections.
3. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
4. Ceiling perimeter and penetrations through the ceiling; and trim and moldings.
5. Minimum Drawing Scale: 1:20.

F. Qualification Data: For testing agency.

G. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each acoustical metal pan ceiling.

H. Evaluation Reports: For each acoustical metal pan ceiling and components and anchor and fastener type.

I. Field quality-control reports.

J. Maintenance Data: For finishes to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Acoustical Testing Agency Qualifications: An independent testing laboratory or an NVLAP-accredited laboratory, with the experience and capability to conduct the testing indicated. NVLAP-accredited laboratories must document accreditation, based on a "Certificate of Accreditation" and a "Scope of Accreditation" listing the test methods specified.

B. Source Limitations:-
1. Acoustical Ceiling Pans: Obtain each type from single source from single manufacturer.
2. Suspension Systems: Obtain each type from single source from single manufacturer.

C. Source Limitations for Acoustical Metal Pan Ceilings: Obtain each combination of acoustical metal pans and exposed suspension systems from one source with resources to provide products of consistent quality in appearance, physical properties, and performance.

D. Surface-Burning Characteristics: Complying with ASTM E 1264 for Class A materials as determined by testing identical products according to ASTM E 84 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.

E. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

F. Pre-installation Conference: Conduct conference at Project site.

G. Cost of Testing Services: By Contractor.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver acoustical metal pans, 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. Handle acoustical metal pans, suspension system components, and accessories carefully to avoid damaging units and finishes in any way.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not install acoustical metal pan ceilings until spaces are enclosed and weather-tight, 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.

1.9 COORDINATION

A. Coordinate layout and installation of acoustical metal pans and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Acoustical Metal Pans: Full-size units equal to 2 percent of quantity installed.
   2. Suspension System Components: Quantity of each grid and exposed molding and trim equal to 2 percent of quantity installed.

PART 2 - PRODUCTS

2.1 ALUMINUM PANS FOR ACOUSTICAL METAL PAN CEILING

A. Aluminum Metal Pans:-
   1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:-
      a. Armstrong World Industries, Inc.
      b. Chicago Metallic Corporation.
      c. Hunter Douglas Architectural Products, Inc.
      d. Or equal approved by Engineer.

B. Pan Fabrication: Manufacturer's standard units of size, profile, and edge treatment indicated, formed from metal indicated and finished to comply with requirements indicated.
   1. Clip-in Pans: Designed to clip-in and be securely retained in exposed suspension grid by formed edges or accessory clips.
   2. Snap-in Pans: Designed with dimples or continuous beads on flanges for snap-in, secure engagement with concealed suspension system.

C. Pan Thickness: Not less than 0.6 mm.

D. Pan Edge Detail: Manufacturer's standard edge detail.

E. Pan Joint Detail: Manufacturer's standard edge detail.

F. Pan Size: 600 x 600mm as indicated on Drawings.

G. Pan Face Finish: to be selected by Engineer from manufacturer's full range.

H. LR: Not less than 0.70.

I. NRC: Not less than 0.60.

J. CAC: Not less than 35.

2.2 METAL SUSPENSION SYSTEMS

A. Metal Suspension System Standard: Provide manufacturer's standard metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable ASTM C 635 requirements.

B. Suspension Systems: Provide systems complete with carriers, runners, splice sections, connector clips, alignment clips, leveling clips, hangers, molding, trim, retention clips, load-resisting struts, and other suspension components required to support ceiling units and other ceiling-supported construction.

C. Attachment Devices: Size for five times the design load indicated in ASTM C 635, 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 per ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.

D. 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. Nickel-Copper-Alloy Wire: ASTM B 164, nickel-copper-alloy UNS No. N04400.
   4. Size: Select wire diameter so its stress at 3 times the hanger design load indicated in ASTM C 635, Table 1, Direct Hung will be less than yield stress of wire, but provide not less than 3.5-mm- diameter wire.

E. Hanger Rods: Mild steel, zinc coated or protected with rust-inhibitive paint.

F. Angle Hangers: Angles with legs not less than 22 mm wide; formed with 1.0-mm- thick, galvanized-steel sheet complying with ASTM A 653/A 653M, G90 (Z275) coating designation; with bolted connections and 8-mm- diameter bolts.

G. Seismic Stabilizer Bars: Manufacturer's standard perimeter stabilizers designed to accommodate seismic forces.

H. Seismic Struts: Manufacturer's standard compression struts designed to accommodate seismic forces.

I. Seismic Clips: Manufacturer's standard seismic clips designed and spaced to secure acoustical metal pans in place.

J. Hold-Down Clips: Manufacturer's standard hold-down clips spaced to secure acoustical metal pans in place to molding and trim at perimeter.

2.3 GENERAL FINISH REQUIREMENTS

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. High-Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.4 ALUMINUM FINISHES

A. Mill Finish: AA-M10C10 (Mechanical Finish: as fabricated, unspecified; Chemical Finish: chemically cleaned).

B. Lacquered Mill Finish: AA-M10C10R1x (Mechanical Finish: as fabricated, unspecified; Chemical Finish: chemically cleaned; Organic Coating: as specified below).
   1. Organic Coating: Manufacturer's standard clear organic coating.

C. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

D. Clear Mirror Anodic Finish: AA-M21C12A212, 0.005 mm or thicker.

E. Color-Coated Finish: Manufacturer's standard[powder-coat] baked paint complying with coating manufacturer's written instructions for surface preparation, pretreatment, application, baking, and minimum dry film thickness.

F. Bright-Reflective Finish: Manufacturer's standard chemical/mechanical bright-reflective metallic finish complying with finish manufacturer's written instructions for surface preparation, pretreatment, process, protective coating, and minimum thickness to produce a finish uniform in appearance and free of blisters, pits, roughness, nodules, burning, cracks, unfinished areas, and other visible defects.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, including structural framing to which acoustical metal pan 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 metal pan ceilings.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Measure each ceiling area and establish layout of acoustical metal pans to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width pans at borders, and comply with layout shown on reflected ceiling plans and Coordination Drawings.

3.3 INSTALLATION

A. Install acoustical metal pan ceilings to comply with ASTM C 636 and seismic requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."

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, counter-splaying, 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 structure to which hangers are attached and type of hanger involved.
6. Do not support ceilings directly from permanent metal forms or floor deck. Fasten hangers to cast-in-place hanger inserts, post-installed 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 (1200 mm) o.c. along each member supported directly from hangers unless otherwise indicated; provide hangers not more than 8 inches (200 mm) 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. Secure bracing wires to ceiling suspension members and to supports with a minimum of four tight turns. Suspend bracing from building's structural members as required for hangers, without attaching to permanent metal forms, steel deck, or steel deck tabs. Fasten bracing wires into concrete with cast-in-place or postinstalled anchors.

D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical metal pans.

E. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.

F. Cut acoustical metal pan units for accurate fit at borders and at interruptions and penetrations by other work through ceilings. Stiffen edges of cut units as required to eliminate evidence of buckling or variations in flatness exceeding referenced standards for stretcher-leveled metal sheet.

G. Install acoustical metal pans in coordination with suspension system and exposed moldings and trim.

1. For clip-in pans, position pans according to manufacturer's written instructions.
2. For snap-in pans, fit adjoining units to form flush, tight joints.
3. Align joints in adjacent courses to form uniform, straight joints parallel to room axis in both directions unless otherwise indicated.
4. Fit adjoining units to form flush, tight joints.
5. Install directionally patterned or textured metal pans in directions indicated.
6. Install sound-absorbent fabric layers in perforated metal pans.
7. Install sound-absorbent pads in perforated metal pans over metal spacer grids.

H. Install hold-down clips where indicated.

3.4 FIELD QUALITY CONTROL

A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
1. Suspended ceiling system.
2. Hangers, anchors, and fasteners.

B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

C. Tests and Inspections: Testing and inspecting of completed installations of acoustical panel ceiling hangers and anchors and fasteners shall take place in successive stages, in areas of extent and using methods as follows. Do not proceed with installations of acoustical panel ceiling hangers for the next area until test results for previously completed installations of acoustical panel ceiling hangers show compliance with requirements.

D. Acoustical panel ceiling hangers and anchors and fasteners will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.5 CLEANING

A. Clean exposed surfaces of acoustical metal pan ceilings, including trim and edge moldings after removing strippable, temporary protective covering, if any. Comply with manufacturer's written instructions for stripping of temporary protective covering, 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, including dented and bent units.

END OF SECTION

SECTION 09632

STONE FLOORING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes marble, granite, slate, limestone, bluestone, and volcanic tuff floor, base, stair tread and riser finish; thin-set or mortar bed application and joint pointing; and thresholds at door openings.

B. Related Sections:
1. Section 03350 - Concrete Finishing: Troweling of floor slab for stone flooring application.
2. Section 07900 - Joint Sealers.

1.2 REFERENCES

A. American National Standards Institute:
1. ANSI A118.1 - Standard Specification for Dry-Set Portland Cement Mortar.
2. ANSI A118.3 - Chemical-Resistant, Water-Cleanable, Tile-Setting and - Grouting Epoxy and Water-Cleanable Tile-Setting Epoxy Adhesive.
3. ANSI A118.4 - Latex-Portland Cement Mortar.
4. ANSI A118.6 - Ceramic Tile Grouts.
5. ANSI A118.8 - Modified Epoxy Emulsion Mortar/Grout.
6. ANSI A136.1 - Organic Adhesives for Installation of Ceramic Tile.

B. ASTM International:
1. ASTM C33 - Standard Specification for Concrete Aggregates.
2. ASTM C144 - Standard Specification for Aggregate for Masonry Mortar.
3. ASTM C150 - Standard Specification for Portland Cement.
4. ASTM C503 - Standard Specification for Marble Dimension Stone (Exterior)
5. ASTM C568 - Standard Specification for Limestone Dimension Stone.
6. ASTM C615 - Standard Specification for Granite Dimension Stone.
7. ASTM C629 - Standard Specification for Slate Dimension Stone.
8. ASTM C1142 - Standard Specification for Extended Life Mortar for Unit Masonry.

C. Tile Council of America:
1. TCA - Handbook for Ceramic Tile Installation.

1.3 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

B. Shop Drawings: Indicate stone layout, patterns, color arrangement, perimeter conditions, junctions with dissimilar materials, control and expansion joints, thresholds, and setting details.
1. Submit stone supplier's installation instructions and field erection drawings.

C. Product Data: Submit instructions for grout.

D. Samples:
1. Submit stone and grout on two plywood panels, size as directed by the Engineer, illustrating pattern, color variations, and grout joint size variations.
2. Submit sample of colored grout.
3. Submit stone samples for sealant compatibility testing.

E. Test Reports: Submit results of sealant adhesion and staining tests.

1.4 CLOSEOUT SUBMITTALS

A. General Requirements: Execution requirements for closeout procedures.

B. Operation and Maintenance Data: Submit recommended cleaning methods, cleaning materials, stain removal methods, and polishes and waxes.
1. Include list of liquids detrimental to appearance of stone finish.

1.5 QUALITY ASSURANCE

A. Perform Work in accordance with TCA Handbook for instructions applicable to mortar setting bed or thin-set bed and grouting.

B. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

A. Fabricator: Company specializing in performing Work of this section with minimum ten years documented experience.

B. Installer: Company specializing in performing Work of this section with minimum five years documented experience.

1.7 MOCKUP

A. General Requirements: Quality requirements for mockup.

B. Construct mock-up, size as directed by the Engineer, including finish grout, and specified accessories.

C. Locate where directed by the Engineer.

D. Remove mockup when directed by the Engineer.

1.8 PRE-INSTALLATION MEETINGS

A. General Requirements: Administrative requirements for pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.9 ENVIRONMENTAL REQUIREMENTS

A. General Requirements: Product requirements.

B. Maintain 10 ºC during installation of flooring materials.

1.10 EXTRA MATERIALS

A. General Requirements: Execution requirements for spare parts and maintenance products.

B. Supply 10 sq m of each size, color, and surface finish of stone flooring specified.

PART 2 PRODUCTS

2.1 STONE FLOORING

A. Fabricators: Any internationally recognized Fabricator having an official technical agreement to conformity with standards for the product.

2.2 COMPONENTS

A. Marble: ASTM C503 Classification I - Calcite, II - Dolomite, III - Serpentine, and/or IV - Travertine; free of defects detrimental to appearance or durability:
1. Unit Size: As indicated on drawings.
2. Thickness: As indicated on drawings.
3. Color: As indicated on drawings.
4. Surface Finish: Polished, Honed, Sandblasted, and/or Abrasive, as indicated on drawings.

B. Granite: ASTM C615; free of defects detrimental to appearance or durability:
1. Unit Size: As indicated on drawings.
2. Thickness: As indicated on drawings.
3. Color: As indicated on drawings.
4. Surface Finish: Polished, Honed, Rubbed, Sawn, Thermal, and/or Sand blasted, as indicated on drawings.

C. Limestone: ASTM C568 Classification I - Low Density, II - Medium Density and/or III - High Density; free of defects detrimental to appearance or durability:
1. Unit Size: As indicated on drawings.
2. Thickness: As indicated on drawings.
3. Color: As indicated on drawings.
4. Surface Finish: Smooth, Split faced, and/or Machined, as indicated on drawings.

D. Slate: ASTM C629 Classification I - Exterior, and/or II - Interior; free of defects detrimental to appearance or durability:
1. Unit Size, Thickness and Color: As indicated on drawings.
2. Surface Finish: Natural cleft, Sand rubbed, and/or Honed, as indicated on drawings.

E. Bluestone: Free of defects detrimental to appearance or durability:
   1. Unit Size: As indicated on drawings.
   2. Thickness: As indicated on drawings.
   3. Color: As indicated on drawings.
   4. Surface Finish: Split face, Rustic face, Pitch face, and/or Sand sawn, as indicated on drawings.

F. Volcanic Tuff: Free of defects detrimental to appearance or durability:
   1. Unit Size: As indicated on drawings.
   2. Thickness: As indicated on drawings.
   3. Color: As indicated on drawings.
   4. Surface Finish: Chisel finish, Sawn face, and/or Rubbed, as indicated on drawings.

G. Skirting/Base: Match flooring for surface finish and color:
   1. Length of units: As indicated on drawings.
   2. Height: As indicated on drawings.
   3. Top Edge: Bull nosed, unless otherwise indicated.
   4. Internal Corner: As indicated on drawings.
   5. External Corner: Bull nosed, unless otherwise indicated.

H. Stair Treads and Risers: Match flooring for surface finish and color; free of defects detrimental to appearance or durability:
   1. Color: As indicated on drawings.
   2. Surface Finish: As indicated on drawings.
   3. Tread Length and Width: As indicated on drawings.
   4. Riser Length and Height: As indicated on drawings.
   5. Thickness: As indicated on drawings.
   6. Exposed Edge: Bull nosed, unless otherwise indicated.

I. Thresholds: Same stone type as flooring, honed finish, size by full width of wall or frame opening, beveled both sides, radiused edges from bevel to vertical face.

J. Organic Adhesive: ANSI A136.1, Type I or II, thin-set bond type.

K. Epoxy Adhesive: ANSI A118.3, thin-set bond type.

L. Stone Setting Adhesive: Elastomeric, waterproof, liquid applied.

M. Mortar Materials: Portland cement, sand, latex additive, and water.

N. Mortar: ASTM C1142, Type RM, RS, RN, and/or RO ready mixed mortar.

O. Mortar Materials: TCA A118.1 Dry Set, Portland cement, sand, and water.

P. Mortar Materials: TCA A118.4 Latex Portland cement, sand, and water.

Q. Portland Cement: ASTM C150, Type I; grey color.

R. Sand: ASTM C144, or ASTM C33, Sharp, coarse, clean, screened sand, free from deleterious materials.

S. Water: Potable.

T. Additives: Plasticizer, Air entraining and/or Bonding agent.

U. Grout: ANSI A118.6, tile grout, color as selected.

V. Grout: ANSI A118.8, modified epoxy emulsion mortar and grout, color as selected.

W. Color Admixture: Site mixed, type as per manufacturer's instructions, and color as selected.

2.3 ACCESSORIES

A. Stone Floor Edging: As indicated on drawings.

B. Sealant: Type specified in Section 07900.

C. Metal Edge Strips: Brass strips, 3mm wide at top edge, with integral provision for anchorage to mortar bed or substrate, unless otherwise indicated.

D. Cleavage Membrane: Polyethylene film, 0.1mm nominal thickness, ASTM D4397.

E. Reinforcing Wire Fabric: Galvanized welded wire fabric, 50mm x 50mm, 1.6mm diameter; comply with ASTM A185 and ASTM A82 except for minimum wire size.

F. Cleaner: Provide stone cleaners of proper formulation for kinds of stones, finishes, and applications indicated as recommended by stone producer and, if sealer specified, by sealer manufacturer. Do no use acid-type cleaning agents or other cleaning compounds containing caustic or harsh fillers, except where expressly approved by stone producer or type of condition involved.

G. Stone Sealer: Colorless, non-yellowing, stain resistant sealer which will not affect color or physical properties of stone surface, as recommended by sealer and stone producer for application indicated.

H. Do not add admixtures including coloring pigments, air-entraining agents, accelerators retarders, water repellent agents, or calcium chloride unless otherwise indicated.

I. Mixing: Combine and thoroughly mix cementitious materials, water, and aggregates in a mechanical batch mixer; comply with referenced ASTM or ANSI standard, as applicable, for mixing time and water content, unless otherwise indicated.

J. Setting Mortars and Grout for Flooring: Comply with mixing requirements of ANSI Standards referenced for materials and installation methods.

K. Fabricate interior stone flooring in sizes and shapes required to comply with requirements indicated, including details on Drawings and final Shop Drawings.
   1. For granite comply with recommendations of National Building Granite Quarries Association, Inc. (NBGQA) as published in "Specifications for Architectural Granite".
   2. For marble comply with recommendations of Marble Institute of America,

Inc. (MIA) as published in “Dimensional Stone - Design Manual III”.

3. For limestone comply with recommendations of the Indiana Limestone Institute of America, Inc. (ILI) as published in the “Indiana Limestone Handbook”.

L. Cut stones to produce pieces of thickness, size, and shape indicated or required and within fabrication tolerances recommended by applicable stone association or stone source, for faces, edges, beds, and backs.

M. Cut stones to produce joints of uniform width and in locations indicated.

1. Joint width: 3mm, unless otherwise stated or shown on the drawings.

N. Clean saw backs of stones to remove rust stains and free iron particles.

O. Finish exposed faces and edges of stones to comply with requirements indicated for finish under each type and application of stone required and to match approved samples and field constructed mock-up.

P. Pattern Arrangement: Where indicated, fabricate and arrange stone panels with veining and other natural markings to comply with the following requirements.

1. Cut stones from 1 block or contiguous, matched blocks in which natural markings occur.

Q. Carefully inspect finished stones at fabrication plant for compliance with requirements relative to qualities of appearance of material and fabrication; replace defective stones with ones that do comply.

R. Grade and mark stones for overall uniform appearance when assembled in place. Natural variations in appearance are acceptable if installed stones match range of colors and other appearance characteristics represented in approved samples and field-constructed mock-ups.

2.4 MIXES

A. Mix and proportion cementitious materials for site made slurry coat and mortar bed.

B. Mix and proportion pre-mix setting bed and grout materials in accordance with TCA Handbook.

C. Add mortar color and admixtures. Control uniformity of mix and coloration.

2.5 FABRICATION

A. Form stone into panel sizes and thickness required.

B. Form stair treads and risers to configuration as detailed.

C. Fabrication Tolerances: As per applicable code.

D. Grain Direction: Vertical and/or Horizontal.

2.6 SOURCE QUALITY CONTROL

A. Provide shop and/or site testing of sealants for compatibility with stone using stone samples provided.

B. Test for adhesion and staining.

PART 3 EXECUTION

3.1 EXAMINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Verify surfaces are ready to receive work.

3.2 PREPARATION

A. Vacuum clean substrate surfaces; damp clean stone.

B. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.

C. Clean stone prior to installation, with edges and surfaces free of dirt or foreign material.

D. Do not use wire brushes or implements capable of marking or damaging exposed surfaces.

3.3 INSTALLATION

A. Installation - Thin-Set Method:
1. Install stone.
2. Install stone, thresholds, stair treads, and grout to TCA Handbook method.
3. Lay stone units to pattern indicated. Do not interrupt tile pattern through openings.
4. Place thresholds at door frame openings.
5. Cut and fit stone units tight to penetrations through unit. Ensure finish trim covers cut edges. Form corners and bases neatly. Align floor and base joints.
6. Maintain uniform joint width subject to variance in tolerance allowed in stone unit size. Make joints watertight, without voids, cracks, excess mortar or excess grout.
7. Maintain joint width of 6 mm where abutting vertical surfaces or protrusions.
8. Sound test units after setting. Replace hollow sounding units.
9. Keep expansion and control joints free of mortar or grout. Apply sealant to joints.
10. Allow thin-set materials to cure prior to grouting.
11. To accommodate joint grout, rake out joints 6 to 10 mm. Grout joints. Pack and work into voids. Neatly tool surface to concave or flush joint.
12. Apply sealant to junction of stone and dissimilar materials and junction of

dissimilar planes.

13. Set stone in full mortar bed to support stone over full bearing surface. Accurately establish joint dimensions.

B. Installation - Mortar Bed Method:

1. Install stone.
2. Install mortar bed, stone, threshold, stair treads, and grout to TCA Handbook method.
3. Apply mortar bed over surfaces to thickness of 15 mm.
4. Lay stone units to pattern indicated. Do not interrupt stone pattern through openings.
5. Set stone in full mortar bed to support stone over full bearing surface.
6. Place thresholds at door frame openings.
7. Cut and fit stone units tight to penetrations through unit. Ensure finish trim covers cut edges. Form corners and bases neatly. Align floor and base joints.
8. Maintain uniform joint width subject to variance in tolerance allowed in stone unit size. Make joints watertight, without voids, cracks, excess mortar or excess grout.
9. Maintain joint width of 6 mm where abutting vertical surfaces or protrusions.
10. Sound test units after setting. Replace hollow sounding units.
11. Keep expansion and control joints free of mortar or grout. Apply sealant to joints.
12. Allow units to set for minimum of 48 hours prior to grouting.
13. To accommodate joint grout, rake out joints 6 to 10 mm. Grout joints. Pack and work into voids. Neatly tool surface to concave or flush joint.
14. Apply sealant to junction of stone and dissimilar materials and junction of dissimilar planes.

C. Install Work in accordance with the drawings, to the manufacturer's instructions and to the approval of the Engineer.

3.4 CLEANING

A. General Requirements: Execution requirements for final cleaning.

B. Clean stone and grout surfaces with cleaner; seal with sealer.

3.5 PROTECTION OF INSTALLED CONSTRUCTION

A. General Requirements: Execution requirements for protecting installed construction.

B. Do not permit traffic over unprotected floor surface.

3.6 SCHEDULES

A. As indicated on drawings and where directed by the Engineer.

END OF SECTION

SECTION 09640

WOOD FLOORING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Particular Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:-

1. French Oak solid wood flooring on terrazzo substrate.

B. Related Sections include the following:-

1. Division 1 Section "LEED Requirements" for additional LEED requirements.
2. Division 6 Section "Rough Carpentry".
3. Division 9 Section “Portland Cement Terrazzo Flooring”

1.3 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Shop Drawings: Show installation details including location and layout of each type of wood flooring and accessory.

C. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors and finishes available for wood flooring.

D. Samples for Verification: For each type of wood flooring and accessory, with stain color and finish required, approximately 300 mm long and of same thickness and material indicated for the Work and showing the full range of normal color and texture variations expected.

E. LEED Submittals:

1. Credit EQ 4.1: Manufacturers' product data for wood flooring installation adhesives, including printed statement of VOC content.
2. Credit EQ 4.2: For field-finished wood flooring, manufacturers' product data for transparent finishes, including printed statement of VOC content and chemical components.
3. Credit EQ 4.4: Composite wood manufacturer's product data for each composite wood product used indicating that the bonding agent contains no urea formaldehyde.

4. Credit MR 7: Certificates of chain-of-custody signed by manufacturers certifying that wood products were made from wood obtained from forests certified by an FSC-accredited certification body to comply with FSC 1.2, "Principles and Criteria." Include evidence that mill is certified for chain-of-custody by an FSC-accredited certification body.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who has completed wood flooring similar in material, design, and extent to that indicated for this Project and whose work has resulted in wood flooring installations with a record of successful in-service performance.

B. Source Limitations: Obtain each species, grade, and cut of wood from one source with resources to provide materials and products of consistent quality in appearance and physical properties.

C. Hardwood Flooring: Comply with NOFMA's "Official Flooring Grading Rules" for species, grade, and cut.

D. Mockups: Install mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. To set quality standards for installation, install mockup of floor area as directed by the Interior Designer.
2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

E. Cost of Testing Services: By Contractor.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver wood flooring materials in unopened cartons or bundles.

B. Protect wood flooring from exposure to moisture. Do not deliver wood flooring until after concrete, masonry, plaster, ceramic tile, and similar wet work is complete and dry.

C. Store wood flooring materials in a dry, warm, ventilated, weather-tight location.

1.7 PROJECT CONDITIONS

A. Conditioning period begins not less than seven days before wood flooring installation, is continuous through installation, and continues not less than seven days after wood flooring installation.

1. Environmental Conditioning: Maintain an ambient temperature between 18 and 24 deg C and relative humidity planned for building occupants in spaces to receive wood flooring during the conditioning period.

2. Wood Flooring Conditioning: Move wood flooring into spaces where it will be installed, no later than the beginning of the conditioning period.
   a. Do not install flooring until it adjusts to relative humidity of, and is at same temperature as, space where it is to be installed.
   b. Open sealed packages to allow wood flooring to acclimatize immediately on moving flooring into spaces in which it will be installed.

B. After conditioning period, maintain relative humidity and ambient temperature planned for building occupants.

C. Install factory-finished wood flooring after other finishing operations, including painting, have been completed.

PART 2 -PRODUCTS

2.1 SOLID-WOOD PARQUET FLOORING

A. Wood Parquet Flooring: Kiln dried to 6 to 9 percent maximum moisture content.

1. Species: French Oak wood.
2. Thickness: 18 mm.
3. Substrate: Terrazzo tiles.
4. Pattern: As indicated.
5. Setting: Fixed with adhesive to terrazzo substrate.
6. Skirting: 70mm high.

2.2 FINISHING MATERIALS

A. Urethane Finish System: Complete system of compatible components that is recommended by finish manufacturer for application indicated.

1. Type: Water based.

2. Stain: Penetrating and non-fading type.

   a. Color: As selected by Interior Designer from manufacturer's full range.

3. Floor Sealer: Pliable, penetrating type.

4. Finish Coats: Formulated for multicoated application on wood flooring.

B. Wood Filler: Formulated to fill and repair seams, defects, and open-grain hardwood floors; compatible with finish system components and recommended by filler and finish manufacturers for use indicated. If required to match approved samples, provide pigmented filler.

2.3 ACCESSORY MATERIALS

A. Sleepers: Moisture content shall not exceed 9 percent. Apply preservative treatment to wood sleepers.

B. Vapor Retarder: ASTM D 4397, polyethylene sheet not less than 0.15mm thick.

C. Wood Flooring Adhesive: Mastic recommended by flooring and adhesive manufacturers for application indicated.

D. Fasteners: As recommended by manufacturer, but not less than that recommended in manufacturer’s instructions."

E. Cork Expansion Strip: Composition cork strip.

F. Feature Strips: In same species and grade as wood flooring, unless otherwise indicated in lengths as long as practical and in thickness to match wood flooring.

G. Trim: In same species and grade as wood flooring, unless otherwise indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas and conditions, with Installer present, for compliance with requirements for maximum moisture content, installation tolerances, and other conditions affecting performance of wood flooring.

1. Verify that substrates comply with tolerances and other requirements specified in other Sections.

2. For adhesively applied wood flooring, verify that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of resilient products.

3. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Substrate Moisture Testing, General: Perform tests recommended by manufacturer.

1. Proceed with installation only after substrates pass testing.

C. Concrete Moisture Testing: Perform anhydrous calcium chloride test per ASTM F 1869, as follows:

1. Perform test so that each test area does not exceed 18.6 sq.m and perform not less than 2 tests in each installation area with test areas evenly spaced in installation area.
2. Proceed with installation only after substrates have maximum moisture-vapor emission rate of 1.36 kg of water/92.9 sq.m in 24 hours.

3. Perform alkalinity and adhesion tests recommended in writing by manufacturer.

3.2 PREPARATION

A. Grind high spots and fill low spots on concrete substrates to produce a maximum 3-mm deviation in any direction when checked with a 3-m straight edge.

1. Use trowelable leveling and patching compounds, according to manufacturer's written instructions, to fill cracks, holes, and depressions in substrates.

B. Remove coatings, including curing compounds, and other substances on substrates that are incompatible with installation adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by manufacturer. Do not use solvents.

C. Broom or vacuum clean substrates to be covered immediately before product installation. After cleaning, examine substrates for moisture, alkaline salts, carbonation, or dust. Proceed with installation only after unsatisfactory conditions have been corrected.

3.3 INSTALLATION

A. Comply with flooring manufacturer's written installation instructions.

B. Pattern: Lay wood flooring in pattern indicated on Drawings or, if not indicated, as directed by the Interior Designer.

C. Provide expansion space at walls and other obstructions and terminations of flooring as indicated on Drawings of not less than 19 mm.

D. Solid-Wood Parquet Flooring: Set in adhesive.

3.4 FINISHING

A. Machine-sand flooring to remove offsets, ridges, cups, and sanding-machine marks that would be noticeable after finishing. Vacuum and tack with a clean cloth immediately before applying finish.

B. Fill open-grained hardwood.

C. Fill and repair wood flooring seams and defects.

D. Apply floor-finish materials in number of coats recommended by finish manufacturer for application indicated, but not less than one coat of floor sealer and three finish coats.

1. Apply stains to achieve an even color distribution matching approved Samples.

2. For water-based finishes, use finishing methods recommended by finish manufacturer to minimize grain raise.

E. Cover wood flooring before finishing.

F. Do not cover wood flooring after finishing until finish reaches full cure, and not before seven days after applying last finish coat.

3.5 PROTECTION

A. Protect installed wood flooring during remainder of construction period with covering of heavy kraft paper or other suitable material. Do not use plastic sheet or film that might cause condensation.

1. Do not move heavy and sharp objects directly over kraft-paper-covered wood flooring. Protect flooring with plywood or hardboard panels to prevent damage from storing or moving objects over flooring.

END OF SECTION

SECTION 09900

PAINTS AND COATINGS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes surface preparation and field application of paints, stains, varnishes, and other coatings.

B. Related Sections:
1. Division 5 - Metals: Shop primed metal items.
2. Division 6 - Wood and Plastic: Shop finished woodwork.
3. Division 8 - Doors and Windows: Shop finished doors, windows and panels.
4. Division 15 - Mechanical: Mechanical Identification.
5. Division 16 - Electrical: Electrical Identification.

1.2 REFERENCES

A. ASTM International:
1. ASTM D16 - Standard Terminology Relating to Paint, Varnish, Lacquer, and Related Products.
2. ASTM D4442 - Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials.

B. Painting and Decorating Contractors of America:
1. PDCA - Architectural Painting Specification Manual.

C. SSPC: The Society for Protective Coatings:
1. SSPC - Steel Structures Painting Manual.

1.3 DEFINITIONS

A. Conform to ASTM D16 for interpretation of terms used in this section.

1.4 SUBMITTALS

A. General Requirements: Requirements for submittal procedures.

B. Product Data: Submit data on finishing products and special coating.

C. Samples:
1. Submit two paper chip samples each 300 x 300 mm, illustrating color range and textures available for each surface finishing product scheduled.
2. Submit two painted samples, illustrating selected colors and textures for each color and system selected with specified coats cascaded.

D. Manufacturer's Installation Instructions: Submit special surface preparation procedures, and substrate conditions requiring special attention.

1.5 CLOSEOUT SUBMITTALS

A. General Requirements: Execution requirements for closeout procedures.

B. Operation and Maintenance Data: Submit data on cleaning, touch-up, and repair of painted and coated surfaces.

1.6 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum ten years documented experience.

B. Applicator: Company specializing in performing work of this section with minimum five years documented experience.

1.7 MOCKUP

A. General Requirements: Quality requirements for mock-up.

B. Construct mockup panel, size as directed by the Engineer, illustrating special coating color, texture, and finish.

C. Construct door and frame assembly illustrating painting, stain and varnish, coating color, texture, and finish.

D. Locate where directed by the Engineer.

E. Remove mockup when directed by the Engineer.

1.8 PRE-INSTALLATION MEETINGS

A. General Requirements: Administrative requirements for pre-installation meeting.

B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE AND HANDLING

A. General Requirements: Product requirements for product storage and handling.

B. Deliver products to site in sealed and labeled containers; inspect to verify acceptability.

C. Container Label: Include manufacturer's name, type of paint, brand name, lot number, brand code, coverage, surface preparation, drying time, cleanup requirements, color designation, and instructions for mixing and reducing.

D. Storage of Paint Materials: Store at minimum ambient temperature of 7ºC and maximum ambient temperature of 32ºC in ventilated area, and as required by manufacturer's instructions.

1.10 ENVIRONMENTAL REQUIREMENTS

A. General Requirements: Product requirements.

B. Do not apply materials when surface and ambient temperatures are outside temperature ranges required by paint product manufacturer.

C. Do not apply exterior coatings during rain/snow, or when relative humidity or moisture content of surfaces exceed those required by paint product manufacturer.

D. Minimum Application Temperatures for Latex Paints: 7ºC for interiors; 10ºC for exterior, unless required otherwise by manufacturer's instructions.

E. Minimum Application Temperature for Varnish Finishes: 18ºC for interior or exterior, unless required otherwise by manufacturer's instructions.

F. Provide lighting level of 860 lx measured mid-height at substrate surface.

1.11 SEQUENCING

A. General Requirements: Requirements for Work sequence.

B. Sequence application to the following:
1 Do not apply finish coats until paintable sealant is applied.
2. Back prime wood trim before installation of trim.

1.12 WARRANTY

A. General Requirements: Execution requirements for product warranties and bonds.

B. Furnish five year manufacturer warranty for paints and coatings.

1.13 EXTRA MATERIALS

A. General Requirements: Execution requirements for spare parts and maintenance products.

B. Supply 4 liters of each color, type and surface texture; store where directed.

C. Label each container with color, type, texture and room locations in addition to manufacturer's label.

PART 2 PRODUCTS

2.1 MANUFACTURER

A. Paint, Transparent Finishes, Stain, Primer Sealers, Block Filler, and Field Catalyzed Coatings Manufacturers: Any internationally recognized manufacturers having an official technical agreement to conformity with standards for the products.

B. Furnish materials as specified, as shown on drawings and to Engineer's satisfaction.

2.2 COMPONENTS

A. Coatings: Ready mixed, except field catalyzed coatings. Process pigments to a soft paste consistency, capable of being readily and uniformly dispersed to a homogeneous coating; prepare coatings for good flow and brushing properties, capable of drying or curing, and free of streaks or sags.

B. Use products of the same manufacturer for succeeding coats. Where primer is shop applied to steel, subsequent coats may be the product of another manufacturer provided the coatings are mutually compatible.

C. Colors, textures and degree of luster shall be as selected by the Engineer. Tint prime and undercoats approximately to the shade of the final coat but with sufficient variation to distinguish them from the preceding coat. Proprietary names used to designate colors or materials, are not intended to imply that products named are required, or to exclude equal products of other manufacturers.

D. Colors of finishes shall not necessarily be manufacturer's stock colors. All materials for finishing coats shall be factory mixed and shall be of a standard quality equal to that of the standard colors of the material specified.

E. Specular Gloss Range:
1. Ranges determined in accordance with ASTM D523:

Sheen	Geometry / Degree	Gloss / Range
Flat	85	Below 15
Eggshell	60	5 to 20
Semi-Gloss	60	30 to 65
Gloss	60	Over 65

2. In locations where ambient temperature and humidity conditions encourage the ready formation of mildew, use paints with additional mildew inhibitive agent incorporate during the manufacturing process, of type and in concentration recommended by the paint manufacturer to withstand such mildew formation.

F. Accessory Materials: Linseed oil, shellac, turpentine, paint thinners and other materials not specifically indicated but required to achieve the finishes specified.

G. Patching Materials: Latex filler.

H. Fastener Head Cover Materials: Latex filler.

2.3 HIGH-PERFORMANCE COATINGS COMPONENTS

A. General: Furnish complete multi-coat systems formulated and recommended by manufacturer for applications indicated, in thicknesses indicated; number of coats specified does not include primer or filler coat.
1. Lead content: None.
2. Chromium content, as zinc chromate or strontium chromate: None.
3. Maximum VOC content: As required by applicable regulations.

4. Colors: As selected from manufacturer's standard colors or as per Drawings.

B. Epoxy Coating: Two coats; polyamide, or polyester epoxy; complying with MIL C-22750; gloss, semi-gloss, or eggshell finish.
1. Percentage of solids by volume: To manufacturer’s recommendations to suit project requirements.
2. Dry film thickness per coat: 150 microns minimum, unless otherwise shown on drawings.
3. Comply with performance requirements of MIL C-22750

C. Epoxy Floor Coating: Two coats, two-part, polyamide or polyester epoxy, non-skid.
1. Percentage of solids by volume: To manufacturer’s recommendations to suit project requirements.
2. Dry film thickness per coat: 200 microns minimum including aggregates, unless otherwise shown on drawings.
3. Comply with performance requirements of MIL C-22750.

D. Primers: As recommended by coating manufacturer for specific substrate with a minimum of 50 microns dry film thickness.

E. Shellac: Pure, white type.

PART 3 EXECUTION

3.1 EXAMINATION

A. General Requirements: Administrative requirements for coordination and project conditions.

B. Verify surfaces and substrate conditions are ready to receive Work as instructed by product manufacturer.

C. Examine surfaces scheduled to be finished prior to commencement of work. Report conditions capable of affecting proper application.

D. Test shop applied primer for compatibility with subsequent cover materials.

E. Measure moisture content of surfaces using electronic moisture meter. Do not apply finishes unless moisture content of surfaces are below the following values:
1. Plaster and Gypsum Boards: 12 percent.
2. Masonry, Concrete and Concrete Unit Masonry: 12 percent.
3. Wood: 15 percent, measured in accordance with ASTM D 4442.
4. Concrete Floors: 8 percent.

3.2 PREPARATION

A. Surface Appurtenances: Remove or mask electrical plates, hardware, light fixture trim, escutcheons, and fittings prior to preparing surfaces or finishing.

B. Surfaces: Correct defects and clean surfaces capable of affecting work of this section.

Remove or repair existing coatings exhibiting surface defects.

C. Marks: Seal with shellac those which may bleed through surface finishes.

D. Impervious Surfaces: Remove mildew by scrubbing with solution of tetra-sodium or tri-sodium phosphate and bleach. Rinse with clean water and allow surface to dry.

E. Aluminum Surfaces Scheduled for Paint Finish: Remove surface contamination by steam or high pressure water. Remove oxidation with acid etch and solvent washing. Apply etching primer immediately following cleaning.

F. Asphalt, Creosote, or Bituminous Surfaces Scheduled for Paint Finish: Remove foreign particles to permit adhesion of finishing materials. Apply latex based, or compatible sealer or primer.

G. Insulated Coverings: Remove dirt, grease, and oil from canvas and cotton.

H. Concrete Floors: Remove contaminations, acid etch and rinse floors with clear water. Verify required acid-alkali balance is achieved. Allow to dry.

I. Copper Surfaces Scheduled for Natural Oxidized Finish: Remove contamination by applying oxidizing solution of copper acetate and ammonium chloride in acetic acid. Rub on repeatedly for required effect. Once attained, rinse surfaces with clear water and allow to dry.

J. Copper Surfaces Scheduled for Paint Finish: Remove contamination by steam, high pressure water, or solvent washing. Clean and immediately apply vinyl etch primer.

K. Gypsum Board Surfaces: Fill minor defects with filler compound. Spot prime defects after repair.

L. Galvanized Surfaces: Remove surface contamination and oils and wash with solvent. Apply coat of etching primer.

M. Concrete and Unit Masonry Surfaces Scheduled to Receive Paint Finish: Remove dirt, loose mortar, scale, salt or alkali powder, and other foreign matter. Remove oil and grease with solution of tri-sodium phosphate; rinse well and allow to dry. Remove stains caused by weathering of corroding metals with solution of sodium meta-silicate after thoroughly wetting with water. Allow for drying.

N. Plaster Surfaces: Fill hairline cracks, small holes, and imperfections with latex patching plaster. Make smooth and flush with adjacent surfaces. Wash and neutralize high alkali surfaces.

O. Uncoated Steel and Iron Surfaces: Remove grease, mill scale, weld splatter, dirt, and rust. Where heavy coatings of scale are evident, remove by hand or power tool wire brushing or sandblasting; clean by washing with solvent. Apply treatment of phosphoric acid solution, ensuring weld joints, bolts, and nuts are similarly cleaned. Spot prime paint after repairs.

P. Shop Primed Steel Surfaces: Sand and scrape to remove loose primer and rust.

Feather edges to make touch-up patches inconspicuous. Clean surfaces with solvent. Prime bare steel surfaces. Prime metal items including shop primed items.

Q. Interior Wood Items Scheduled to Receive Paint Finish: Wipe off dust and grit prior to priming. Seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after primer has dried; sand between coats.

R. Interior Wood Items Scheduled to Receive Transparent Finish: Wipe off dust and grit prior to sealing, seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes and cracks after sealer has dried; sand lightly between coats.

S. Exterior Wood Scheduled to Receive Paint Finish: Remove dust, grit, and foreign matter. Seal knots, pitch streaks, and sappy sections. Fill nail holes with tinted exterior paintable caulking compound after prime coat has been applied.

T. Exterior Wood Scheduled to Receive Transparent Finish: Remove dust, grit, and foreign matter; seal knots, pitch streaks, and sappy sections with sealer. Fill nail holes with tinted exterior caulking compound after sealer has been applied.

U. Glue-Laminated Wood: Prior to finishing, wash surfaces with solvent, remove grease and dirt.

V. Wood Doors Scheduled for Painting: Seal wood door top and bottom edge surfaces with clear sealer or tinted primer.

W. Metal Doors Scheduled for Painting: Prime metal door top and bottom edge surfaces.

3.3 EXISTING WORK

A. Extend existing paint and coatings installations using materials and methods compatible with existing installations and as specified.

3.4 APPLICATION

A. Do not apply finishes to surfaces that are not dry. Allow applied coats to dry before next coat is applied.

B. Apply each coat to uniform appearance. Apply each coat of paint slightly darker than preceding coat unless specified otherwise.

C. Sand wood and metal surfaces lightly between coats to achieve required finish.

D. Vacuum clean surfaces of loose particles. Use tack cloth to remove dust and particles just prior to applying next coat.

E. Where clear finishes are required, tint fillers to match wood. Work fillers into grain before set. Wipe excess from surface.

F. Prime concealed surfaces of interior and exterior woodwork with primer paint.

G. Prime concealed surfaces of interior wood surfaces scheduled to receive stain or

varnish finish with gloss varnish reduced 25 percent with thinner.

H. Finishing Mechanical and Electrical Equipment:
   1. Refer to Divisions 15 and 16 for schedule of color coding and identification banding of mechanical and electrical equipment, duct, piping, conduit, etc.
   2. Paint shop primed equipment.
   3. Remove unfinished louvers, grilles, covers, and access panels on mechanical and electrical components and paint separately.
   4. Prime and paint insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, except where items are shop finished.
   5. Paint interior surfaces of air ducts and convector and baseboard heating cabinets visible through grilles and louvers with one coat of flat black paint to visible surfaces. Paint dampers exposed behind louvers, grilles, and convector and baseboard cabinets to match face panels.
   6. Paint exposed conduit and electrical equipment occurring in finished areas.
   7. Paint both sides and edges of plywood backboards for electrical and telephone equipment before installing equipment.
   8. Color code equipment, piping, conduit and exposed duct work in accordance with requirements indicated or color schedule. Color band and identify with flow arrows, names and numbering.
   9. Reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing.

I. Install Work as specified, as shown on drawings, in accordance with manufacturer's instructions, and to the satisfaction of the Engineer.

3.5 INSTALLATION - FIBER REINFORCED EPOXY COATING/LINING

A. Prepare the surfaces including sandblasting and air cleaning.

B. Apply one layer of an approved coal tar pitch epoxy coating, 200 microns thick, as per manufacturer's recommendations.

C. Place one layer of approved fiberglass reinforcements before the applied epoxy coating is completely dry, as per manufacturer's recommendations.

D. Apply another two layers of the approved coal tar pitch epoxy coating, 200 microns thick each.

E. Place plastic panel facing with approved adhesive materials.

3.6 FIELD QUALITY CONTROL

A. General Requirements: Quality requirements for testing and inspection services, and execution requirements for testing, adjusting and balancing.

B. Inspect and test questionable coated areas in accordance with applicable code.

3.7 CLEANING

A. General Requirements: Execution requirements for final cleaning.

B. Collect waste material which may constitute fire hazard, place in closed metal containers, and remove daily from site.

3.8 SCHEDULES - SHOP PRIMED ITEMS FOR SITE FINISHING

A. Shop primed items for site finishing are stated under Division 5 (i.e.: Section 05500, etc.)

3.9 SCHEDULES - EXTERIOR SURFACES

A. Wood - Painted (Opaque):
   1. One coat of latex or alkyd primer sealer.
   2. Two coats of alkyd or latex enamel, gloss or semi-gloss.

B. Wood - Transparent:
   1. Two coats of stain.

C. Wood - Shingles and Shakes:
   1. One coat of stain or clear sealer.
   2. Two coats of clear sealer.

D. Glue-Laminated Wood and Wood Timber Members:
   1. One coat of stain or sealer.
   2. Two coats of varnish, gloss or semi-gloss.

E. Pavement Markings:
   1. Two coats of thermoplastic reflectorized paint, yellow or white.

F. Concrete, Concrete Block, Restored Masonry and Cement Plaster:
   1. One coat of primer sealer latex or alkyd.
   2. Two coats of latex or alkyd, flat.

G. Gypsum Board and Cement Plaster Soffits:
   1. One coat of primer sealer latex or alkyd.
   2. Two coats of latex or alkyd, flat.

H. Structural Steelwork: Refer to individual specification sections of Division 5.

I. Architectural Steel - Unprimed:
   1. One coat of latex or alkyd primer.
   2. Two coats of alkyd or latex enamel, gloss or semi-gloss.

J. Architectural Steel - Shop Primed:
   1. Touch-up with zinc chromate or zinc rich primer.
   2. Two coats of alkyd or latex enamel, gloss or semi-gloss.

K. Architectural Steel - Galvanized:
   1. One coat galvanized primer.

2. One mordant coat.
3. Two coats of alkyd or latex enamel, gloss or semi-gloss.

L. Aluminum - Mill Finish:
1. One coat etching primer.
2. Two coats of alkyd enamel, gloss.

M. Copper:
1. One coat etching primer.
2. Two coats of alkyd enamel, gloss.

3.10 SCHEDULES - INTERIOR SURFACES

A. Wood - Painted:
1. One coat of latex or alkyd prime sealer.
2. Two coats of alkyd or latex enamel, gloss, semi-gloss, eggshell or flat.

B. Wood - Intumescent Coating:
1. One coat of prime sealer.
2. Two coats of intumescent coating.

C. Wood - Transparent:
1. Filler coat (for open grained wood only).
2. Two coats of stain.
3. One coat sealer.
4. Two coats of varnish, gloss, satin or flat.

D. Cabinet Interior:
1. One coat of latex or alkyd prime sealer.
2. One coat of alkyd or latex enamel, semi-gloss or flat.

E. Glue-Laminated Wood and Wood Timber Members:
1. One coat of stain or sealer.
2. Two coats of varnish, gloss, satin or flat.

F. Concrete, Concrete Block, Restored Masonry and Cement Plaster:
1. One coat of primer sealer latex or alkyd.
2. Two coats of latex or alkyd, flat or semi-gloss.

G. Structural Steelwork: Refer to individual specification sections of Division 5.

H. Architectural Steel - Unprimed:
1. One coat of alkyd or latex primer.
2. Two coats of alkyd or latex enamel, gloss or semi-gloss.

I. Architectural Steel - Primed:
1. Touch-up with alkyd or latex primer.
2. Two coats of alkyd or latex enamel, gloss or semi-gloss.

J. Architectural Steel - Galvanized:
1. One coat galvanized primer.

2. One mordant coat.
3. Two coats of alkyd or latex enamel, gloss or semi-gloss.

K. Aluminum - Mill Finish:
1. One coat etching primer.
2. Two coats of alkyd enamel, gloss.

L. Concrete Floors:
1. One coat of alkali resistant or catalyzed epoxy primer.
2. Two coats of alkyd floor enamel or catalyzed epoxy enamel, gloss.

M. Gypsum Board and Plaster Walls:
1. One coat of alkyd primer sealer.
2. Two coats of alkyd, latex or latex acrylic enamel, gloss, semi-gloss, eggshell or flat.

N. Gypsum Board and Plaster Ceilings:
1. One coat of alkyd primer sealer.
2. Two coats of alkyd, latex or latex acrylic enamel.

O. Wall Surfaces Under Vinyl Wall Covering:
1. Two coats of alkyd primer sealer.

P. Fire Retardant Finish:
1. One coat of fire retardant primer.
2. Two coats of fire retardant finish, gloss.
3. Flame and smoke rating of 25/50.

Q. Insulated Coverings - Canvas and Cotton:
1. One coat of alkyd primer sealer.
2. Two coats of alkyd enamel, gloss, semi-gloss, eggshell or flat.

3.11 SCHEDULES - COLORS

A. As indicated on drawings and/or as selected by the Engineer from manufacturer's range and samples.

END OF SECTION

SECTION 033053 - MISCELLANEOUS CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes cast-in-place concrete, including reinforcement, concrete materials, mixture design, placement procedures, and finishes.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Sustainable Design Submittals:

C. Design Mixtures: For each concrete mixture.

1.3 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

PART 2 - PRODUCTS

2.1 CONCRETE, GENERAL

A. Comply with ACI 301 (ACI 301M).

B. Comply with ACI 117 (ACI 117M).

2.2 STEEL REINFORCEMENT

A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.

B. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064/A 1064M, plain, fabricated from as-drawn steel wire into flat sheets.

2.3 CONCRETE MATERIALS

A. Cementitious Materials:

1. Portland Cement: ASTM C 150/C 150M, [**Type I**] [**Type II**] [**Type I/II**] [**Type III**] [**Type V**].
2. Fly Ash: ASTM C 618, Class C or F.
3. Slag Cement: ASTM C 989/C 989M, Grade 100 or 120.
4. Blended Hydraulic Cement: ASTM C 595/C 595M, [**Type IS, portland blast-furnace slag**] [**Type IP, portland-pozzolan**] [**Type IL, portland-limestone**] [**Type IT, ternary blended**] cement.

B. Normal-Weight Aggregate: ASTM C 33/C 33M, **1-1/2-inch (38-mm)** nominal maximum aggregate size.

C. Air-Entraining Admixture: ASTM C 260/C 260M.

D. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and that do not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Retarding Admixture: ASTM C 494/C 494M, Type B.
3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.

E. Water: ASTM C 94/C 94M.

2.4 FIBER REINFORCEMENT

A. Synthetic Micro-Fiber: [**Monofilament**] [**or**] [**fibrillated**] polypropylene micro-fibers engineered and designed for use in concrete, complying with ASTM C 1116/C 1116M, Type III.

2.5 RELATED MATERIALS

A. Vapor Retarder: Plastic sheet, ASTM E 1745, Class A or B.

B. Vapor Retarder: Polyethylene sheet, ASTM D 4397, not less than 10 mils (0.25 mm) thick; or plastic sheet, ASTM E 1745, Class C.

C. Joint-Filler Strips: ASTM D 1751, asphalt-saturated cellulosic fiber, or ASTM D 1752, cork or self-expanding cork.

2.6 CURING MATERIALS

A. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

B. Absorptive Cover: AASHTO M 182, Class 3, burlap cloth or cotton mats.

C. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

D. Water: Potable.

E. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B.

F. Clear, Membrane-Forming Curing and Sealing Compound: ASTM C 1315, Type 1, Class A.

2.7 CONCRETE MIXTURES

A. Normal-Weight Concrete:

1. Minimum Compressive Strength: **30 MPa** at 28 days.
2. Maximum W/C Ratio: **0.45**
3. Cementitious Materials: Use fly ash, pozzolan, slag cement, and silica fume as needed to reduce the total amount of portland cement, which would otherwise be used, by not less than 40 percent.
4. Slump Limit: **4 inches (100 mm) for concrete with verified slump of 2 to 4 inches (50 to 100 mm) before adding high-range water-reducing admixture or plasticizing admixture**], plus or minus 1 inch (25 mm).
5. Air Content: Maintain within range permitted by ACI 301 (ACI 301M). Do not allow air content of trowel-finished floor slabs to exceed 3 percent.

2.8 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M[**and ASTM C 1116/C 1116**], and furnish batch ticket information.

1. When air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK INSTALLATION

A. Design, construct, erect, brace, and maintain formwork according to ACI 301 (ACI 301M).

3.2 EMBEDDED ITEM INSTALLATION

A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

3.3 VAPOR-RETARDER INSTALLATION

A. Install, protect, and repair vapor retarders according to ASTM E 1643; place sheets in position with longest dimension parallel with direction of pour.

1. Lap joints 6 inches (150 mm) and seal with manufacturer's recommended adhesive or joint tape.

3.4 STEEL REINFORCEMENT INSTALLATION

A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

3.5 JOINTS

A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.

B. Contraction Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least **one-fourth** of concrete thickness, as follows:

C. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.

1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface unless otherwise indicated.

3.6 CONCRETE PLACEMENT

A. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301 (ACI 301M).

B. Do not add water to concrete during delivery, at Project site, or during placement.

C. Consolidate concrete with mechanical vibrating equipment according to ACI 301 (ACI 301M).

3.7 FINISHING FORMED SURFACES

A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections exceeding 1/2 inch (13 mm).

1. Apply to concrete surfaces.

B. Rubbed Finish: Apply the following rubbed finish, defined in ACI 301 (ACI 301M), to smooth-formed-finished as-cast concrete where indicated:

1. Smooth-rubbed finish.
2. Grout-cleaned finish.
3. Cork-floated finish.

C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.

3.8 FINISHING UNFORMED SURFACES

A. General: Comply with ACI 302.1R for screeding, restraightening, and finishing operations for concrete surfaces. Do not wet concrete surfaces.

B. Screed surfaces with a straightedge and strike off. Begin initial floating using bull floats or darbies to form a uniform and open-textured surface plane before excess moisture or bleedwater appears on surface.

1. Do not further disturb surfaces before starting finishing operations.

C. Scratch Finish: Apply scratch finish to surfaces indicated and surfaces to receive concrete floor topping or mortar setting beds for ceramic or quarry tile, portland cement terrazzo, and other bonded cementitious floor finishes unless otherwise indicated.

D. Float Finish: Apply float finish to surfaces indicated, to surfaces to receive trowel finish, and to floor and slab surfaces to be covered with fluid-applied or sheet waterproofing, fluid-applied or direct-to-deck-applied membrane roofing, or sand-bed terrazzo.

E. Trowel Finish: Apply a hard trowel finish to surfaces indicated and to floor and slab surfaces exposed to view or to be covered with resilient flooring, carpet, ceramic or quarry tile set over a cleavage membrane, paint, or another thin film-finish coating system.

F. Trowel and Fine-Broom Finish: Apply a partial trowel finish, stopping after second troweling, to surfaces indicated and to surfaces where ceramic or quarry tile is to be installed by either thickset or thinset methods. Immediately after second troweling, and when concrete is still plastic, slightly scarify surface with a fine broom.

G. Slip-Resistive Broom Finish: Apply a slip-resistive finish to surfaces indicated and to exterior concrete platforms, steps, and ramps. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route.

3.9 CONCRETE PROTECTING AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and with ACI 301 (ACI 301M) for hot-weather protection during curing.

B. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

C. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

D. Curing Methods: Cure formed and unformed concrete for at least seven days by one or a combination of the following methods:

1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

   a. Water.
   b. Continuous water-fog spray.
   c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period, using cover material and waterproof tape.
3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Tests: Perform according to ACI 301 (ACI 301M).

1. Testing Frequency: Obtain one composite sample for each day's pour of each concrete mixture exceeding 5 cu. yd. (4 cu. m), but less than 25 cu. yd. (19 cu. m), plus one set for each additional 50 cu. yd. (38 cu. m) or fraction thereof.
2. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. (76 cu. m) or fraction thereof of each concrete mixture placed each day.

END OF SECTION 033053

TABLE OF CONTENTS

DIVISION 1 - GENERAL REQUIREMENTS

SECTION 01100

SUMMARY

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Contract description.
B. Contractor's use of site.
C. Coordination.
D. Work sequence.
E. Owner occupancy.
F. Specification conventions.

1.2 CONTRACT DESCRIPTION

A. Scope:
1. This Specification covers the construction and completion of the project as shown on the Drawings, Bill of Quantities, and as detailed in the Contract Documents and directed by the Engineer.
2. The Contract comprises execution, completion of the works and remedying any defects therein including the provision of all labor, materials, constructional plant, temporary works and everything whether of a temporary or permanent nature required for the execution and completion of the works.
3. Perform Work in accordance with the Contract Documents.
4. The requirements of this Section do not supersede or take precedence over any provision of the “General Conditions of Contract” and the “Conditions of Particular Applications”, and should any discrepancy become apparent between the requirements of this Section and the “General Conditions of Contract” and the “Conditions of Particular Applications”, the Contractor shall notify the Engineer, in writing, with a copy to the Employer, and the Engineer shall interpret and decide such matters in accordance with the applicable provisions of the Tender Documents.
5. The organization of the Specifications into Divisions, Sections and paragraphs and the arrangement of Drawings shall not necessarily control the Contractor in dividing the Work among sub-contractors or in establishing the extent of Work to be performed by any trade.
6. In examining the requirements of any section of the Specifications, the Contractor shall examine all other sections of the Specifications and the other Documents and Drawings which affect the Work of that section.
7. It is the responsibility of the Contractor, to inform the Engineer of any discrepancies in the drawings and specifications before signing the Contract, default of which will make him responsible for any errors or omissions even though they have been approved by the Engineer.

B. Description of the Project:
1. The project location is as shown on the drawings.
2. The project comprises the construction and completion of the subject works with all related siteworks, civil and architectural works, and electromechanical works.

C. The performance required of materials and products and the standards to be complied with shall be as specified in subsequent sections of these Specifications and in accordance with local relevant authorities' standards

D. Cross References:

1. The specifications are prepared based on the Construction Specifications Institute (CSI) master format.
2. The specifications section numbers and titles are used in the Bill of Quantities as cross-references to help define the part or parts of the Specification which apply to particular kinds of work or parts of the Work. If the references are to specific clauses or kinds or types of work within a section of the Specifications, they shall be taken as applying to the section as a whole, with all related sections and other relevant information. Cross references should not be taken as excluding other relevant information and requirements stated in other parts or sections of the Specifications. The Specifications as a whole shall be taken as applying to the Work as a whole.

1.3 CONTRACTOR'S USE OF SITE

A. All construction operations and site establishment facilities shall be confined to within the site boundaries unless otherwise agreed with the Engineer and Employer.

B. The Contractor shall be responsible for safeguarding all existing structures.

C. The Contractor shall be responsible for arranging his own working space, storage of materials, setting of all temporary accommodations, utilities, services, facilities, etc.

D. The Contractor shall be responsible for keeping driveways and entrances serving the site clear and available to the Employer, the Employer's employees, and emergency vehicles at all times. Do not use these areas for parking or storage of materials. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

E. The Contractor shall be responsible for not unreasonably encumber the site with materials or equipment. Confine stockpiling of materials and location of storage sheds to the areas proposed by the Contractor at Tender stage, after having received the approval of the Engineer. If additional storage is necessary, obtain and pay for such storage off site.

F. The Contractor shall be responsible for locking automotive type vehicles, such as passenger cars & trucks and other mechanized or motorized construction equipment, when parked and unattended, so as to prevent unauthorized use. Do not leave such vehicles or equipment unattended with the motor running or the ignition key in place.

1.4 COORDINATION

A. The Contractor shall be responsible to coordinate all the works related to the project.

B. The Contractor shall ensure that the Works are carried out in proper sequence having regard to the works progress, and that all necessary provisions are made for locating, routing, supporting and fixing the engineering services, providing necessary holes, chases and access for them, and in all respects fully integrating them with the works.

1.5 WORK SEQUENCE

A. Construct Work in approved stages and phases.

B. Coordinate construction schedule and operations with Engineer.

1.6 OWNER OCCUPANCY

A. Owner will occupy the site and premises at the date stated in the Contract Document.

B. Cooperate with Owner to minimize conflict, and to facilitate Owner's operations.

C. Schedule the Work with the Engineer to accommodate Owner occupancy.

1.7 ` SPECIFICATION CONVENTIONS

A. These specifications are written in imperative mood and streamlined form. This imperative language is directed to the Contractor, unless specifically noted otherwise. The words “shall be” are included by inference where a colon ":" or semi-colon ";" is used within sentences or phrases.

B. Related Sections: All "Division 1" specifications sections are general requirement sections and are applicable to all other specifications sections and no need to mention them in the “Related Sections” of each specifications section; In general, “Related Sections” are only the “Technical Related Sections”.

END OF SECTION

SECTION 01300

ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Coordination and project conditions.
B. Field engineering.
C. Regulatory Requirements.
D. Management and Administration Procedures.
E. Progress meetings.
F. Pre-installation meetings.

1.2 COORDINATION AND PROJECT CONDITIONS

A. Coordinate scheduling, submittals and Work of various sections of the Project to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.

B. Verify utility requirements and characteristics of operating equipment are compatible with project utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, operating equipment.

C. Coordinate space requirements, supports and execution of all trades and works. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance and for repairs.

D. Coordinate completion and clean-up of Work of separate sections in preparation for Substantial Completion.

1.3 FIELD ENGINEERING

A. Scope:
1. This section covers:
a. Survey and field engineering, quality control, submittals and project record documents of the works.
b. The Contractor’s responsibility for the accurate setting out of the Works both on drawings and on Site.

B. Related Items:
1. General Requirements: Execution requirements for project record documents.

C. Performance and Standards:
1. Employ a Certified Land Surveyor acceptable to the Engineer to perform survey work of this section.
2. All setting out, including the setting out and marking of builder’s work requirements shall be measured from agreed data.

D. Submittals:
1. Submit name, address, and telephone number of Surveyor before starting survey work.
2. On request, submit documentation verifying accuracy of survey work.
3. Submit a copy of site drawing signed by the Certified Land Surveyor, that the elevations and locations of the Work are in conformance with Contract Documents.
4. Maintain a complete and accurate log of control and survey work as it progresses.

E. Examination:
1. Verify locations of survey control points prior to starting work.
2. Promptly notify Engineer of any discrepancies discovered.

F. Survey Reference Points:
1. Contractor will locate and protect survey control and reference points.
2. Control datum for survey is that indicated on Drawings or as given by the Engineer.
3. Verify set-backs and easements; confirm drawing dimensions and elevations.
4. Protect survey control points prior to starting site work; preserve permanent reference points during construction.
5. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Engineer.

G. Survey Requirements:
1. Provide field engineering services. Utilize recognized engineering survey practices.
2. Establish a minimum of four permanent bench marks on site, referenced to established control points. Record locations, with horizontal and vertical data, on project record documents.
3. Establish elevations, lines and levels. Locate and lay out by instrumentation and similar appropriate means:
   a. Site improvements including pavements; stakes for grading; utility locations, slopes, and invert elevations.
   b. Grid or axis for structures of existing and new structures.
   c. Column locations, ground floor elevations, and roof elevation of existing and new structure.
4. Periodically verify layouts by same means.

H. Existing Levels:
1. The Contractor shall satisfy himself that the levels as shown on the drawings are correct. Should the Contractor wish to dispute any levels he shall submit to the Engineer a schedule of the position of the levels considered to be in error and a set of revised levels. Levels shall not be disturbed during execution without the approval of the Engineer.
2. Claims brought on discrepancies due to non compliance by the Contractor of the aforementioned shall not be considered.

I. Tolerances:
1. Survey tolerance shall be to agreed recognized standards in addition to the local relevant authorities' regulations and standards.

1.4 REGULATORY REQUIREMENTS

A. Scope: This Specification calls attention to the regulations to be observed by the Contractor and the Standards and Codes of Practice to which reference shall be made.

B. Regulations:
   1. The Contractor shall carry out the Works in full observance of the local authorities. Special attendance shall be also given to:
      a. General Requirements, Site Administration, Safety, Health and Environmental Regulations.
      b. Regulations and planning of the Municipality or local authority.
   2. All agencies involved to which a notice of intent should be declared and from which approvals should be obtained.

C. Standards:
   1. Notwithstanding the Specifications of certain Standards and Codes of Practice, all Materials, Products and Workmanship shall comply with the requirements of the latest edition of all relevant and current Standards, Standard Codes of Practice and all current amendments thereto.
   2. Compliance shall be understood to mean that the standard attained shall not be less than that specified in the Standard or Code of Practice and may well be higher. In particular, where a higher standard is called for in the Specification that higher standard shall take precedence over the relevant Standard and Code of Practice, even if these are referred to in the text of the Specification.
   3. In the case of materials and products which have been produced or manufactured in accordance with a published Standard or Code, that fact shall be brought to the attention of the Engineer together with full particulars of the standard in question which will be accepted by the Engineer if he is satisfied as to its provisions.

1.5 MANAGEMENT AND ADMINISTRATION PROCEDURES

A. General: Management shall be to agreed recognized standards or manuals.

B. Superintendence:
   1. Accept responsibility for coordination, superintendence and administration of the Work including all sub-contracts.
   2. Arrange and monitor a programme with each sub-Contractor, supplier and local authority, obtain and supply information as necessary for coordination of Works.

C. Sub-Contractor’s Site Meeting: Hold meetings with appropriate sub-contractors and suppliers shortly before main site meetings to facilitate accurate reporting of progress.

D. Weather Record: Keep an accurate record of:
   1. Daily maximum and minimum air temperature (including overnight)
   2. Number of hours per day in which Work is prevented by inclement weather.

1.6 PROGRESS MEETINGS

A. Schedule and administer meetings throughout progress of the Work at maximum monthly intervals unless otherwise directed by the Engineer.

B. Make arrangements for meetings in full coordination with the Engineer; prepare agenda with copies for participants, preside at meetings.

C. Attendance Required: Job superintendent, major subcontractors and suppliers, Owner, and Engineer, as appropriate to agenda topics for each meeting.

D. Agenda:

1. Review minutes of previous meetings.
2. Review of Work progress.
3. Field observations, problems and decisions.
4. Identification of problems impeding planned progress.
5. Review of submittals schedule and status of submittals.
6. Review of off-site fabrication and delivery schedules.
7. Maintenance of progress schedule.
8. Corrective measures to regain projected schedules.
9. Planned progress during succeeding work period.
10. Coordination of projected progress.
11. Maintenance of quality and work standards.
12. Effect of proposed changes on progress schedule and coordination.
13. Other business relating to Work.

E. Record minutes and distribute copies within two days after meeting to participants, with two copies to Engineer, Owner and those affected by decisions made.

1.7 PRE-INSTALLATION MEETINGS

A. When required in individual specification sections, convene pre-installation meetings at Project site prior to commencing work of specific section.

B. Require attendance of parties directly affecting, or affected by, Work of specific section.

C. Notify the Engineer minimum four days in advance of meeting date.

D. Prepare agenda and preside at meeting:

1. Review conditions of installation, preparation and installation procedures.
2. Review coordination with related work.

E. Record minutes and distribute copies within two days after meeting to participants, with two copies to Engineer, Owner and those affected by decisions made.

END OF SECTION

SECTION 01323

NETWORK ANALYSIS SCHEDULES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. References.
B. Quality assurance.
C. Format.
D. Construction Program.
E. Submittals.
F. Distribution.

1.2 REFERENCES

A. The Use of CPM in Construction: A Manual for General Contractors and the Construction Industry, Washington, D.C., The Associated General Contractors of America (AGC).

B. CPM in Construction Management: Project Management with CPM, O'Brien, McGraw-Hill Book Company, New York.

1.3 QUALITY ASSURANCE

A. Scheduler: Contractor's personnel or Specialist Consultant specializing in CPM scheduling with ten years minimum experience in scheduling construction work of complexity comparable to this Project, and having use of computer facilities capable of delivering detailed graphic printout within 48 hours of request.

B. Contractor's Administrative Personnel: Ten years minimum experience in using and monitoring CPM schedules on comparable projects.

1.4 FORMAT

A. Listings: Reading from left to right, in ascending order for each activity. Identify each activity with applicable specification section number.

B. Diagram Sheet Size: 600 mm high x 900 mm wide or by the required width.

C. Scale and Spacing: To allow for notations and revisions.

1.5 CONSTRUCTION PROGRAM

A. The Contractor shall prepare a Construction Program showing the order and method in which he proposes to execute the works and the dates upon which the various elements, trades and sections of the works will be started and completed, including dates for submittal and approval of shop drawings and samples, for procurement and delivery of materials and equipment; for construction, installation, inspection, testing and commissioning.

B. The construction program shall be in the form of Computerized Network Precedence Diagrams incorporating activities for all work to be performed by the Contractor, his Sub-Contractors and other Contractors to be employed in or about the site, supported by computer analysis and schedules and prepared in accordance with the principles of Critical Path Method (CPM) programming.

C. The construction program shall be prepared by a qualified Network Analysis Consultant in collaboration with the Contractor. The Network Analysis Consultant shall be approved by Engineer and shall be skilled and experienced in construction programming of the kind specified for this project. The Network Analysis Consultant shall provide the Engineer access to his database for loading into the Engineer's computer system, whether by means of floppy diskettes or data-line communications.

D. The network diagrams shall be clearly and accurately presented with work activities relating to specific locations or levels grouped for ease of reference. Each work activity shall have the following information shown in the diagram:
   1. Activity Number.
   2. Concise Description of the Work.
   3. Specification Reference or Trade Code.
   4. Location of Work or Area Code.
   5. Duration in Calendar day.

E. Computer Analysis:
   1. In addition to the network diagrams the Contractor shall submit the following computer analysis output:
      a. Activity Status Report.
      b. Master Working Report: Chronological listing by early start of all activities and milestones.
      c. Milestone Report: Chronological listing by early start of allmilestones.
      d. Contractor Reports: Individual report, sorted chronologically by early start, for each Sub-Contractor. These reports will only have the early start and early finish dates for distribution to Sub-Contractors.
      e. Material Procurement Report: Based on the early start Construction Program, for all material items. This report shall include dates for submittal, approval release for ordering/fabrication, shipping and delivery to site.
      f. Shop Drawings and Samples Reports: This schedule shall detail the dates for submission and approval of shop drawings and samples required by the Contract Documents, including those required from Sub-Contractors, and shall make due allowance for reasonable time of processing of shop drawings by the Engineer.
      g. Man Power Report: A listing of all activities displaying estimated crew sizes and manpower requirements for each activity.
      h. Current Status Report: A listing of actual start and finish dates, activities already started and completed and percentage completion of activities still in progress.
      i. Cash Flow Report: Showing projected monthly and cumulative expenditure.
   2. The activity status report shall have the following minimum data for each activity
      a. Activity Number.
      b. Concise description of the work.

c. Specification reference or trade code.
d. Location of work or trade code.
e. Duration in calendar days.
f. Early start date (calendar).
g. Early finish date (calendar).
h. Late start date (calendar).
i. Late finish date (calendar).
j. Total float (calendar days).
k. Estimate crew size.
l. Percentage completion.
m. Remaining duration in calendar days.

F. Supporting Data:

1. The Contractor shall also prepare and submit in narrative form the supporting data noted below with the submittal of his Construction Program. Any changes in this information shall be submitted with successive updates and revision.
   a. The proposed number of working days per week.
   b. The holidays, and other non-working days observed during the duration of the Contract (by date).
   c. The planned number of shifts per day.
   d. The number of hours per shift.
   e. The planned usage of major construction plant and equipment on the site, on a monthly basis.
   f. The planned procurement and delivery of local and imported materials.
   g. The average weekly manpower usage for each trade to be employed for the works.
   h. The productivity rates for each major work sequence or for any specific activities required by the Engineer.
   i. Explanation of all changes in logic, durations, manpower, plant and equipment.
   j. Actual start and finish dates of activities already completed, and percentage completion of activities still in progress.

G. Forty Five (45) Day Program: At monthly intervals, the Contractor shall submit a separate program developed from the approved Construction Program covering a period of forty five calendar days and denoting the Contractor's and Sub-Contractor's daily work activities and their interrelationship with the work of other Contractors, if any.

H. Construction Program Revisions and Updates

1. Once the initial Construction Program is submitted and approved by the Engineer, the Network Analysis Consultant shall perform monthly updates in collaboration with the Contractor. The update will follow a visit to the job site where in the presence of the Engineer, the Network Analysis Consultant and the Contractor will record the actual starts and percentages complete and, using this data, update the computer analysis. The updated analysis will be accompanied by a narrative report containing the supporting data referred to herein before, which shall indicate the necessary action dates and requirements for material, labour and plant acquisition. The narrative report shall also focus upon the construction progress and shall particularly note conditions that may delay progress of the work. In the event of such delays, the Contractor shall describe actions proposed to overcome the delay and to maintain the planned construction program.

2. Site Progress meetings attended by the Engineer, the Contractor, the Network Analysis Consultant and the principal Sub-Contractors, will be held monthly, immediately following the monthly site visit referred to in the previous paragraph, specifically to review the progress of the work. At this meeting the latest update of the last approved Construction Program will be examined with reference to the records made during the said site visit in order to verify the following:
    a. Actual start and finish dates of activities completed during the period since the previous update or revision.
    b. Remaining durations and percentage of completion for all activities in progress.
    c. Logic, time and cost data for variation order work that will be incorporated into the Construction Program.
    d. Contractor's measures to rectify delays from the planned dates.
3. The Contractor shall perform the work in accordance with the latest approved Construction Program. If any work is found not to be on program during any regular review of the work, the Contractor shall immediately advise the Engineer in writing of action proposed to bring the work back on program. The Contractor shall thereupon prepare and submit a revised Construction Program indicating such action, together with a list of revisions to program logic. Correction and updating of the program will be done as often as necessary until the project is back on program.
4. Within 5 working days after receipt of a notice from Engineer, the Contractor shall submit a revised Construction Program for any of the following reasons:
    a. When delays in completion of any activity or group of activities indicates a slippage of the Contract completion date or a milestone date by fourteen (14) calendar days or ten percent (10%) of the remaining duration of the Contract period, whichever is less.
    b. When delays in submittals or deliveries or work stoppage are encountered which make re-planning of the work necessary.
    c. When the program does not represent the actual execution and progress of the work being performed in the field.
    d. Where a change in the work sequence is proposed or has been instituted by the Contractor. Any such change should not, in any case, be made without the Engineer's approval.
    e. Where the issue of a change order or other instruction would significantly affect the program and/or progress of the works.
5. In the event the Contractor requests an extension of time for completion of the works or requests an extension to the specified milestone dates, he shall furnish such justification and supporting data as the Engineer may deem necessary for the evaluation thereof. Submission of proper substantiation based on revised activity logic, durations and costs is obligatory with any such request.
6. Float belongs to the project and must be used in the best interest of completing the project on time. Accordingly, any existing float shall be used to the maximum extent possible to offset unexpected delays which occur in connection with the Contractor's work, acts of God (Force Majeur), and authorized variations in the scope of the work.

I. Programming Costs:
    1. All costs in establishing, maintaining, revising and updating the construction program shall be borne by the Contractor.

1.6 SUBMITTALS

A. General Requirements: Submittal procedures.

1.7 DISTRIBUTION

A. Following revisions and/or monthly updates to the Construction Program, distribute copies of updated schedules to Contractor's project site file, to Subcontractors, suppliers, Engineer, Owner, and other concerned parties.

B. Instruct recipients to promptly report, in writing, problems anticipated by projections shown in schedules.

END OF SECTION

SECTION 01330

SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Scope.
B. Definitions.
C. Submittal Procedures.
D. Engineer’s Representative Review of Submittals.

1.2 SCOPE

A. This section generally specifies procedures regarding submittals and the required submittals for the Contract. However, additional procedures and requirements for submittals are specified in individual sections of the specifications.

B. Submittals shall include but not limited to the following:
1. Submittal schedule.
2. Coordination and sequencing.
3. Submittal preparation and procedure.
4. Product data.
5. Construction program.
6. Design by Contractor.
7. Shop drawings and samples.
8. Design data.
9. Certificates.
10. Test and inspection reports.
11. Manufacturer's instructions.
12. Manufacturer's field reports.
13. Miscellaneous submittals.
14. Site layout organization chart.
15. Progress reports.
16. Correspondence.
17. CAD produced drawings.
18. Photographs of construction progress.

C. The list and schedule of all submittals and approvals should be compatible with the project schedule.

D. The requirements of this section do not supersede or take precedence over any provision of the Conditions of Contract. Should any discrepancy become apparent between these requirements and the conditions of contract, the requirements of the conditions of contract shall prevail.

1.3 DEFINITIONS

A. The work related to submittals of this section, in addition to the definitions of the conditions of Contract and elsewhere in the contract documents, are further

categorized for convenience as follows:

1. Product data shall include manufacturer's latest standard printed literature such as manufacturer's installation instructions, catalog cuts, colour charts, roughing diagrams, wiring diagrams, and performance curves on materials, equipment and systems for this project. Product data shall include references to applicable specification section and item number. Product data shall be in addition to the required shop drawing submittals.
2. Any design required by the Contractor, where called for in the Contract Documents, shall include all necessary calculations, working drawings and shop drawings.
3. Construction Program shall be in the form of Computerized Network Precedence Diagrams incorporating activities for all work to be performed by the Contractor, his Sub-Contractors and other Sub-Contractors to be employed in or about the Site, supported by computer analysis and schedules and prepared in accordance with the principles of Critical Path Method Programming.
4. Shop drawings shall include specially prepared technical data with diagrams, performance curves, data sheets, schedules, templates, patterns, reports, calculations, plans, sections, details and measurements in standard printed form (size A0 for drawings and Schdules, and size A4 for others). Shop drawings shall be in addition to the required product data and shall indicate applicable specification section and item numbers.
5. Samples shall include physical examples of materials, both fabricated and unfabricated, in complete units and as smaller portions of units, for visual inspection and where stated, for more detailed testing and analysis. Samples shall indicate applicable section and item numbers within that section.
6. Certificates shall include statements of suitability, certifying reports from governing agencies, industry standards and testing agencies and applicable certificates specified in each section of the specification.
7. Test and inspection reports shall include reports specified to be required in each section of the specifications.
8. Schedules shall include schedule of required submittals organized by related specification section number and sequence of submission, schedule of sequence of work and time schedule, schedule of sequence of application of specific units of work and schedule of materials, equipment and systems as listed in applicable sections of the specifications.
9. Miscellaneous submittals shall include submittals related directly to the work (non-administrative) including warranties, maintenance agreements, workmanship bonds, survey data and reports, physical work records, copies of industry standards, record drawings, field measurement data, operating and maintenance materials, overrun stock, security/protection/safety keys and similar information, devices and materials applicable to the work and not processed as shop drawings, product data, samples or certificates.

1.4 SUBMITTAL PROCEDURES

A. General:

1. Transmit each submittal with Engineer accepted form.
2. Sequentially number transmittal forms. Mark revised submittals with original number and sequential alphabetic suffix.
3. Identify Project, Contractor, Sub-Contractor and Supplier; pertinent drawing and detail number, and specification section number, appropriate to submittal.

4. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction Work, and coordination of information are in accordance with requirements of the Work and Contract Documents.
5. Schedule submittals to expedite Project, and deliver to Engineer at business address. Coordinate submission of related items.
6. Identify variations from Contract Documents and product or system limitations which may be detrimental to successful performance of completed Work.
7. Allow space on submittals for Contractor and Engineer review stamps.
8. When revised for resubmission, identify changes made since previous submission.
9. Distribute copies of reviewed submittals as appropriate. Instruct parties to promptly report inability to comply with requirements.
10. Submittals not requested will not be recognized or processed.

B. Submittal Schedule:
1. All submittals and correspondence shall be submitted to the Engineer.
2. Any design required by the Contractor, where called for, shall be submitted to the Engineer for approval.
3. All shop drawings, material and samples submittal schedules shall be submitted to the Engineer for approval. In addition the Contractor shall submit Material delivery schedule for Engineer’s approval. The Contractor shall adhere to the approved schedules.
4. Schedule submissions to ensure that the Engineer is allowed a reasonable time to review each submission within the scheduled period of time.
5. Certify that each submittal has been checked and approved by Sub-Contractors, installers, manufacturers and suppliers. Note any deviations from drawings or specifications.
6. No submissions shall be processed without signed & approved certification of Contractor. This certification shall be stated on each submission as follows:
Materials submitted for approval has been checked for conformance with drawings and specifications for this project. Any deviations from plans and specifications have been noted on the material or listed in the transmittal letter.
Signed
_____
(Contractor)

C. Coordination and Sequencing:
1. Coordinate preparation and processing of submittals with the Construction Program and progress so that the work will not be delayed.
2. Coordinate and sequence submittals for work and work interfaced with other work so that the processing of submittals will not be delayed by the lack of required coordination between submittals.
3. The obligation to coordinate the work indicated on any submittal material with other trades and with field conditions is the responsibility of the Contractor. No claim will be allowed for work that may have to be moved or replaced based on a claim that the work was placed in accordance with dimensions indicated on an approved submittal.
4. No claim for an extension of Contract Time will be granted because of Contractor’s failure to coordinate submissions.

D. Submittal Preparation and Procedure:

1. The Contractor shall prepare and submit to the Engineer for approval any design required by the Contractor where called for, shop drawings including method statements, coordination drawings and final construction details, samples of materials, product data including data sheet and manufacturer's data, catalogues and specifications, and all other submittals stated hereinafter and required in each individual specification section.
2. Each submittal shall be accompanied by a "Transmittal" form whose format shall be to the approval of the Engineer and shall indicate the following:
    a. Contract №: Contractor's name and job number.
    b. Specification Section: The specification section number of item specified. (Do not submit items from more than one specification on the same form).
    c. Submitted by: Name of Contractor's employee responsible for Contractor's review.
    d. Contract Works Title: Name of Contract.
    e. Transmittal №: Numbers shall be consecutive for the Works.
    f. Date Submitted: Date on which any design by the Contractor where called for, shop drawings and sample leave Contractor's office.
    g. Contractor: Name of firm preparing (and/or Supplier) original documents (any Design required by the Contractor where called for, Shop Drawings or Samples).
    h. Submission №: 1st, 2nd, 3rd, etc., depending on previous submission for same items (see re-submittal procedure).
    i. Bill of Quantities: Bill or division, item and description.
    j. Specification Section Paragraph: Specific paragraph under which item is specified.
    k. Copies and Type: Number of copies submitted and type of material submitted (print, brochure or sample, etc.).
    l. Drawing №, Description and Date: Number of the Drawing. Title on the submission (where possible) and date on the submission. Where a group of related drawings are submitted as one unit, only one entry need to be made with a general description of what is included. (Drawings should then be numbered consecutively and have the same date).
    m. Contractor's Remarks: Clearly note any exceptions or deviations from the Contract Documents and state reasons for them.
3. The Contractor shall plan the submission process in good time to meet the requirements of the program allowing for twenty one (21) days for engineering review and approval and for extra time for resubmission in the case of rejection. In all case he should plan to get the approval minimum thirty (30) days prior to the scheduled activity early start or the material purchase order.
4. Resubmission: Re-submittal procedures shall follow the same procedures as the initial submittal with the following exceptions:
    a. Transmittal shall contain the same information as the first transmittal except that transmittal numbers shall run consecutively and the submission number shall indicate 2nd, 3rd, etc. submission. The drawing number/description shall be identical to the initial submission and the date shall be the revised date for that submission.
    b. No new material shall be included on the same transmittal for a

resubmission.

c. Once a sample, whether material or other, is submitted and approved then no alternative shall be submitted unless a valid and necessary reason is given to substantiate the submission of this alternative. Such reason shall be acceptable to the Engineer.

5. Engineer's and Engineer's Representative Action on Transmittal Form: Incomplete or erroneous transmittals will be returned with directives indicated.

6. Submittal Procedures by Contractor:

a. All correspondence and attachments thereto shall be submitted to the Engineer in one original and five copies and one digital/soft copy.

b. Six prints and one digital/soft copy of each shop drawing with transmittal forms shall be submitted to the Engineer's Representative.

c. Two samples of each material or prefabricated component with transmittal forms to the Engineer.

d. Six copies of brochures, one of which must be original, with transmittal forms to the Engineer.

E. Product Data:

1. Within 15 days after Contract implementation commencement date, submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product called for under "Submittals" in each individual specification section.

2. For products specified only by reference standards, give manufacturer, trade name, model or catalog designation, and reference standards.

3. Submit product data in triplicate for review. Indicate the actual materials being submitted for review when literature contains selections.

4. Indicate product utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

F. Construction Program (Specified in "Network Analysis Schedules" Section):

1. Program Submittal Procedures and Requirements:

a. The Contractor shall submit his initial Construction Program for approval, in four copies and one digital, within 3 weeks of the Contract implementation commencement date, unless otherwise stated in the Conditions of Contract. Such initial Construction Program shall include the following completed documents:

1) Network Precedence Diagram showing the sequence and interdependence of all items of work required under the Contract and milestone dates.

2) All the computer analysis report required under this Contract.

b. After approval of the Contractor's initial Construction Program, all subsequent revision and monthly update submittals shall comprise the following:

1) Four (4) prints of the Network Diagrams from the last approved Construction Program, suitably marked up in red ink to show all revisions, and signed by the Contractor and all Sub-Contractors.

2) Four (4) copies of the updated Activity Status Report.

3) Four (4) copies of all supporting data.

4) Four (4) copies of the master working report.

c. Revisions and monthly updates to the Construction Program shall be

submitted within five (5) working days of the data date for inputting revised/updated information to create the revision/updated computer analysis. The data date for the first monthly update shall be one month after approval by the Engineer of the Contractor's initial Construction Program, and successive data dates shall be at monthly intervals. The said data date should coincide with the date of the site progress meeting at which time the records of progress are verified.

d. Each program submitted shall be signed by all principal Sub-Contractors including Nominated (if any) before being submitted to the Engineer thereby confirming that they have reviewed the said program. If any Sub-Contractor has reservations regarding his ability to comply with the program requirements to which he has appended his signature, the Contractor shall instruct the Sub-Contractor to list such reservations in writing and a copy thereof shall be submitted to the Engineer with the program submittal for his information. No reservation by any Sub-Contractor, nor the fact of informing the Engineer in respect thereof, shall relieve the Contractor of his responsibilities under the Contract in the time prescribed therein.

e. Submit a bi-weekly report detailing the preparation, submittal and approval status of shop drawings, materials and equipment, samples and mock-ups and the status of materials and equipment procurement, order placed, delivery periods and site delivery dates.

2. Programming Costs:

a. All costs in establishing, maintaining, revising and updating the construction program shall be borne by the Contractor.

G. Design by Contractor:

1. Any design required by the Contractor, where called for, together with all necessary calculations, working and shop drawings, shall be submitted to the Engineer within 15 days after Contract implementation commencement date.
2. The design by Contractor, together with all necessary calculations, working drawings and shop drawings shall be prepared by the Contractor and by his principal Sub-Contractors for structural, architectural and electro-mechanical works, proper liaison and coordination between trades shall be attended to and ensured. Contractor shall also allow the Engineer's access for review and approval during the preparation process.
3. The design by Contractor shall be prepared after site dimensions have been taken. Shop drawings shall be prepared on reproducible transparencies, and using metric units of measurement.
4. The Engineer's review and approval of any design required by the Contractor, is for general conformance with the design concept and specifications and shall not relieve the Contractor from responsibility for errors or omissions in respect of the requirements of any standards and codes.
5. The Contractor shall make any corrections or amendments required by the Engineer's review of the design required by Contractor including calculations, working drawings and shop drawings, and shall resubmit until the "APPROVED" status is achieved. All such corrections or amendments shall be clearly indicated on the resubmitted design with all necessary calculations, working drawings and shop drawings, by the use of revision numbers in circles or triangles, or other method approved by the Engineer.
6. No acceptance or approval by the Engineer of any design made by the

Contractor, nor any notes, comments, stipulations, requests for clarifications, etc., made by the Engineer upon such submissions during his review and approval thereof, shall constitute an authorization to any variation in the Contract price or to any extra time for completion of the works.

H. Shop Drawings and Samples: Shop drawings shall establish actual details of manufactured or fabricated items and of work to be executed; they shall clearly identify materials, dimensions, thicknesses, components, attachments, relation with adjoining work and spaces, and all other pertinent information. Shop drawings shall clarify and amplify the design drawings and other design requirements and shall, subject to the Engineer's approval, incorporate minor changes in design or construction as may be necessary or otherwise desirable to suit the requirements of the work. Where the Contract Documents require the Contractor to submit samples, the same shall satisfactorily establish that the quality, construction, workmanship, finish, color, pattern and any other characteristics of the material or equipment to be provided, are in conformance with the Contract requirements and to the Engineer's reasonable satisfaction.

1. The Contractor shall prepare, review, coordinate and submit to the Engineer for his approval such shop drawings and samples as are required by the Contract Documents or as may be required by the Engineer during the course of the works.
2. At the time of making his submission, the Contractor shall inform the Engineer in writing of any deviation between shop drawings/samples being submitted and the requirements stipulated or reasonably implied by the Contract Documents.
3. By submitting shop drawings and samples, the Contractor thereby represents that he has determined and verified all dimensions, relation to existing work, coordination with the work to be installed later, coordination with information in previously submitted shop drawings and has verified their compliance with all the requirements of the Contract Documents. The accuracy of all such information is the responsibility of the Contractor and in reviewing shop drawings and samples, the Engineer shall be entitled to rely upon the Contractor's representation that such information is correct and accurate. The Contractor shall be responsible for and shall make any alterations in the work due to discrepancies, errors or omissions are not due to inaccurate the Engineer. The Contractor shall be responsible for the correct locations of his work, irrespective of approval by the Engineer, and shall pay all costs and expenses incurred by others due to improper location of his work.
4. Sub-Contractors shall submit their shop drawings and samples through the Contractor who shall review and coordinate with his own and other Sub-Contractor's drawings and/or samples before submitting to the Engineer. The Contractor shall be responsible in all respects for his Sub-Contractor's shop drawings and samples as if they were his own.
5. Neither the fabrication of prefabricated items, nor the ordering of any work, materials or equipment, nor the execution of any work on site, shall commence until shop drawings and samples, relevant to the said items, work, etc., and required by the specifications, have been submitted and approved in writing by the Engineer.
6. Shop drawings shall be prepared by the Contractor and by his principal Sub-Contractors for structural, architectural and electro-mechanical works, proper

liaison and coordination between trades shall be attended to and ensured. Contractor shall also allow the Engineer's access for review and approval during the preparation process.

7. Shop drawings and samples shall be prepared after site dimensions have, if possible, been taken. Shop drawings shall be prepared on reproducible transparencies, and using metric units of measurement.
8. Shop drawings shall describe accurately the method of fabrication, installation, applied finishes, types and sizes of all members and fixings, and shall, where applicable, indicate methods of marking components for site erection. Shop drawings shall be to scales approved by the Engineer.
9. The Contractor shall verify all dimensions and field conditions and shall check and coordinate the shop drawings and samples required in connection with a particular trade or section of the works with the requirements of other trades or section related thereto.
10. In order to ensure proper coordination, shop drawings and samples for each system or element of work shall be submitted in a single package. The Engineer may require in writing that all relevant parts of a system or element be submitted before any component item is approved.
11. Except for finish, pattern, colour and other matters in respect of which the Engineer's decision is required in accordance with the Contract Documents, the Engineer's review and approval of shop drawings and samples submitted by the Contractor is for general conformance with the design concept and specifications and shall not relieve the Contractor from responsibility for any deviation from, or errors or omissions in respect of the requirements of the Contract Documents, unless the Contractor has informed the Engineer in writing of specific deviations and the Engineer has given written approval thereto.
12. The Contractor shall make any corrections or amendments required by the Engineer's review of shop drawings and samples, and shall resubmit until the "APPROVED" status is achieved. All such corrections or amendments shall be clearly indicated on the resubmitted drawings and samples by the use of revision numbers in circles or triangles, or other method approved by the Engineer.
13. The Contractor shall direct specific attention in writing or resubmitted shop drawings and samples to revisions other than the corrections requested by the Engineer or previous submissions. Unless such written notice has been given, approval of a resubmitted shop drawing or sample shall not constitute approval of any changes not requested on the prior submission.
14. In the event of written rejection by the Engineer to a particular sample of material, the Contractor shall submit within fourteen (14) days of such rejection, samples of three alternative materials for the Engineer's approval and the Engineer shall reject or approve all or any of these materials within fourteen (14) days of their submission. This procedure shall be repeated until such time as a sample of material is approved by the Engineer. Failure on the part of the Contractor to obtain the Engineer's approval, which shall not be withheld unreasonably, to all or any one sample or material shall in no way relieve the Contractor of his liabilities and obligations under the Contract.
15. The Engineer may at any time call upon the Contractor to submit samples of any material used or to be used in the work, including those specified in the Contract by "Brand Name", for comparison with the specification and/or approved sample. Should any such sample fail to meet the requirements of

the specification and/or standard of the accepted sample, then all materials from which the sample has been taken shall be removed from the site immediately and all work executed incorporating such material shall be removed and made good to the satisfaction of the Engineer all at the expense of the Contractor.

16. No acceptance or approval by the Engineer of any shop drawing or sample submission made by the Contractor, nor any notes, comments, stipulations, requests for clarifications, etc., made by the Engineer upon such submissions during his review and approval thereof, shall constitute an authorization to any variation in the Contract price or to any extra time for completion of the works.

I. Design Data:
   1. Submit for Engineer's knowledge as contract administrator or for Owner.
   2. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

J. Certificates:
   1. When specified in any specification section under "Submittals", submit certification by manufacturer, installation or application sub-contractor, or Contractor to Engineer, in quantities specified for Product Data.
   2. Indicate material or product conforms to or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
   3. Certificates may be recent or previous test results on material or Product, but must be acceptable to the Engineer.
   4. Submit certificates in triplicate for review.

K. Test and Inspection Reports:
   1. Submit test and inspection reports called for in each specification section.
   2. Submit test reports for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

L. Manufacturer's Instructions:
   1. When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, to Engineer for delivery to Owner in quantities specified for Product Data.
   2. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

M. Manufacturer's Field Reports:
   1. Submit reports for Engineer's benefit as contract administrator or for Owner.
   2. Submit report in duplicate within 14 days of observation to Engineer for information.
   3. Submit for information for limited purpose of assessing conformance with information given and design concept expressed in Contract Documents.

N. Miscellaneous Submittals:
   1. Refer to each individual specification section and the Contract Documents for additional submittal requirements.

O. Site Layout Organization Chart:

1. The Contractor shall prepare and submit to the Engineer's Representative for his approval, a site layout organization plan, and any modifications thereafter showing the Contractor's proposed layout of his temporary construction facilities and controls, and his plant and equipment on site.

P. Progress Reports:

1. Monthly Progress Reports: The Contractor shall submit to the Engineer each month a progress report showing the actual progress of work by identifying activities and works commenced and/or completed during the previous month with progress photographs, activities and works to be carried out during the following month, and the estimated time required to complete all activities and works in relation to the programme of works. Such reports shall be to the satisfaction of the Engineer.
2. Daily/Weekly Progress Reports: To be provided for the work required, if any, where expressly stated in its related specification section.

Q. Correspondence: Except where more are required by the contract, all correspondence shall be through the Engineer, and shall be submitted as follows:

1. One original and two photocopies of transmittals and letters including attachments/enclosures.

R. CAD Produced Drawings:

1. The Contractor shall prepare his shop drawings, progress record drawings, and final as-built drawings using computer aided design and drafting techniques (CAD).
2. All computer hardware, software and computer room necessary for the preparation of drawings using CAD shall be provided by the Contractor at no additional cost.
3. Data indicating inappropriate or unacceptable Work may be subject to action by Engineer or Owner.

S. Photographs of Construction Progress:

1. During the progress of the work, submit in triplicate, colored photographs taken one a month by an approved professional photographer consisting of 20 views, all taken where directed by the Engineer. Prints shall be 130 x 180 mm matt finish, unless otherwise stated in the Conditions of Contract.
2. At the completion of all work final photographs shall be taken as directed by the Engineer.
3. Identify each print on back. Identify Name of Project, Contract Number, orientation of view, date and time of view, name and address of photographer, and photographer's numbered identification of exposure.
4. All negatives or soft copies in case of digital camera shall be delivered to the Employer in their proper order, and shall become the Employer's property. Include typed table of contents of all photographs in chronological sequence.
5. The Contractor shall submit photographs for all works to be covered before covering such works to the approval of the Engineer.

T. Penalty for Delays in Submittal of any Document or Schedule: The Engineer may, following written notice to the Contractor, deduct from payments to the Contractor an amount of money as a penalty for each delay in Submittal of any Document or

Schedule (minimum 200 US $ per calendar day per document or per schedule).

1.5 ENGINEER'S REPRESENTATIVE REVIEW OF SUBMITTALS

A. The Engineer's Representative will process the submission and indicate the appropriate action on the submission and the transmittal, and will note major deviations from the Engineer's Contract Documents or reasons for resubmit if there are not notes on the material submitted.

END OF SECTION

SECTION 01400

QUALITY REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Quality control and control of installation.
B. Tolerances.
C. References.
D. Mock-up requirements.
E. Testing and inspection services.
F. Manufacturers' field services.
G. Examination.
H. Preparation.

1.2 QUALITY CONTROL AND CONTROL OF INSTALLATION

A. The Contractor shall submit Quality Assurance Program consisting of the Quality Assurance Manual, Project Quality Assurance Plan. Such program shall be subject to the Engineer’s approval.

B. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.

C. Comply with manufacturers' instructions, including each step in sequence. When manufacturers' instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

D. Comply with specified standards as minimum quality for the Work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.

E. Perform Work by persons qualified to produce required and specified quality.

F. Verify field measurements are as indicated on shop drawings or as instructed by manufacturer.

G. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

1.3 TOLERANCES

A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.

B. Comply with manufacturers' tolerances. When manufacturers' tolerances conflict with Contract Documents, request clarification from Engineer before proceeding.

C. Adjust products to appropriate dimensions; locate before securing products in place.

1.4 REFERENCES

A. Whenever specific standards, brands, trades, etc. are mentioned, equivalent equal are acceptable without stating "or equivalent" each time.

B. For products or workmanship specified by association, trades, or other consensus standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.

C. Conform to reference standard by date of issue current on date of Contract Documents, except where a specific date is established by code.

D. Obtain copies of standards where required by product specification sections.

E. When specified reference standards conflict with Contract Documents, request clarification from the Engineer before proceeding.

F. Neither the contractual relationships, duties, responsibilities of the parties in Contract, nor those of the Engineer shall be altered from the Contract Documents by mention or inference otherwise in any reference documents.

1.5 MOCK-UP REQUIREMENTS

A. Tests will be performed under provisions identified in this section and identified in the respective product specification sections.

B. Assemble and erect specified items with specified attachment and anchorage devices, flashings, seals and finishes.

C. Accepted mock-ups shall be comparison standard for the remaining Work.

D. Where mock-up has been accepted by Engineer and is specified in product specification sections to be removed; remove mock-up and clear area when directed to do so by Engineer.

E. Submit drawings showing location and details of Mockup plus a description report of Mockup.

F. Submit test certificates for tests to be undertaken.

G. Testing operations may include, but not limited to, weather tests, seismic, water, air, wind resistance, permeability and load safety.

H. Submit test reports for Visual and Tests of Mockups: Indicate substantiating engineering data, test results of previous tests by independent laboratory which purport to meet performance criteria and other supportive data.

1.6 TESTING AND INSPECTION SERVICES

A. Scope:
   1. This section covers testing services including selection and payment, contractor submittals, agency responsibilities, agency reports, limits on testing authority, Contractor responsibilities and schedule of tests.
   2. Employment and payment for services of an independent testing agency or laboratory to perform specified testing shall be borne by the Contractor.
   3. Employment of testing agency or laboratory in no way relieves Contractor's obligation to perform Work to the requirements of the Contract Documents.

B. Performance and Standards:
   1. ASTM C802: Practice for Conducting an Inter-laboratory Test Program to Determine the Precision of Test Methods for Construction.
   2. ASTM C1021: Practice for Laboratories Engaged in the Testing of Building Sealants.
   3. ASTM C1077: Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.
   4. ASTM C1093: Practice for Accreditation of Testing Agencies for Unit Masonry.
   5. ASTM E329: Practice for Use in the Evaluation of Inspection and Testing Agencies as Used in Construction.
   6. ASTM E543: Practice for Determining the Qualification of Nondestructive Testing Agencies.
   7. ASTM E548: Practice for Preparation of Criteria for Use in the Evaluation of Testing Laboratories and Inspection Bodies.
   8. ASTM E699: Practice for Criteria for Evaluation of Agencies Involved in Testing, and Evaluating Building Components in Accordance with Test Methods Promulgated by ASTM Committee E6.
   9. ASTM E779: Standard Test Method for Determining Air Leakage Rate by Fan Pressurization.

C. Submittals:
   1. Prior to start of Work, submit testing laboratory name, address, and telephone number and names of full time specialist and responsible officer to the Engineer for approval.
   2. Submit copy of report of laboratory facilities inspection made, with memorandum of remedies of any deficiencies reported by the inspection.

D. The independent firm will perform tests, inspections and other services specified in individual specification sections and as required by the Engineer.
   1. Laboratory: Authorized to operate at Project location.
   2. Laboratory Staff: Maintain full time registered Engineer or specialist on staff to review services.
   3. Testing Equipment: Calibrated at reasonable intervals with devices of accuracy traceable to National Bureau of Standards or accepted values of natural physical constants.

E. Testing, inspections and source quality control may occur on or off project site. Perform off-site testing as required by the Engineer or Owner.

F. Reports will be submitted by independent firm to the Engineer and Contractor, in

duplicate, indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.

G. Cooperate with independent firm; furnish samples of materials, design mix, equipment, tools, storage, safe access, and assistance by incidental labor as requested.
   1. Notify the Engineer and the independent firm 24 hours prior to expected time for operations requiring services.
   2. Make arrangements with independent firm and pay for additional samples and tests required for Contractor's use.

H. Testing and employment of testing agency or laboratory shall not relieve the Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

I. Re-testing or re-inspection required because of non-conformance to specified requirements shall be performed by same independent firm on instructions by the Engineer. Payment for re-testing or re-inspection will be charged to Contractor by deducting testing charges from Contract Sum/Price.

J. Agency Responsibilities:
   1. Test samples of mixes submitted by Contractor.
   2. Provide qualified personnel at site. Cooperate with Engineer and Contractor in performance of services.
   3. Perform specified sampling and testing of Products in accordance with specified standards.
   4. Ascertain compliance of materials and mixes with requirements of Contract Documents.
   5. Promptly notify Engineer and Contractor of observed irregularities or nonconformance of Work or Products.
   6. Perform additional tests required by Engineer.
   7. Attend preconstruction meetings and progress meetings.

K. Agency Reports:
   1. After each test, promptly submit four copies of report to Engineer and to Contractor.
   2. Include the following:
      a. Date issued.
      b. Project title and number.
      c. Name of inspector.
      d. Date and time of sampling or inspection.
      e. Identification of product and specifications section.
      f. Location in Project.
      g. Type of inspection or test.
      h. Date of test.
      i. Results of tests.
      j. Conformance with Contract Documents.
   3. When requested by Engineer, provide interpretation of test results.

L. Limits on Testing Authority:
   1. Agency or laboratory may not release, revoke, alter, or enlarge on requirements of Contract Documents.

2. Agency or laboratory may not approve or accept any portion of the Work.
3. Agency or laboratory may not assume duties of Contractor.
4. Agency or laboratory has no authority to stop the Work.

M. Contractor's Responsibilities:
1. Deliver to agency or laboratory at designated location, adequate samples of materials proposed to be used which require testing, along with proposed mix designs.
2. Cooperate with laboratory personnel, and provide access to the Work and to manufacturer's facilities.
3. Provide incidental labor and facilities:
   a. To provide access to Work to be tested.
   b. To obtain and handle samples at the site or at source of Products to be tested.
   c. To facilitate tests.
   d. To provide storage and curing of test samples.
4. Notify Engineer and laboratory 36 hours prior to expected time for operations requiring testing services.

N. Schedule of Tests:
1. Individual Specification Section: Tests required and standards for testing.

1.7 MANUFACTURERS' FIELD SERVICES

A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test and adjust and balance of equipment as applicable, and to initiate instructions when necessary.

B. Submit qualifications with CV of observer to the Engineer, thirty (30) days in advance of required observations. The Observer shall be subject to the approval of the Engineer.

C. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent Work. Beginning any new Work, means acceptance of existing conditions.

B. Verify that existing substrate is capable of structural support or attachment of new Work being applied or attached.

C. Examine and verify specific conditions described in individual specification sections.

D. Verify that utility services are available, of correct characteristics and in the correct locations.

3.2 PREPARATION

A. Clean substrate surfaces prior to applying next material or substance.

B. Seal cracks or openings of substrate prior to applying next material or substance.

C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

END OF SECTION

SECTION 01500

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 GENERAL

1.1 SCOPE

A. Section includes provision, maintenance during Contract implementation and removal at the end of the entire project of the following:
   1. Temporary Utilities: Electricity, lighting for construction purposes, site lighting, heating, cooling, ventilation, telephone service, facsimile service, water service, and sanitary facilities.
   2. Temporary Controls: Barriers, enclosures, fences and gates, security, traffic safety and regulation, water control, dust control, erosion and sediment control, noise control, pest control, pollution control, rodent control, and first aid facilities.
   3. Construction Facilities: Parking, progress cleaning and waste removal, project identification, field offices and sheds, vehicular access, plant and small tools, and scaffolding and hoisting.

1.2 PERFORMANCE AND STANDARDS

A. The Contractor shall abide fully by the provisions and requirements of all regulations imposed by relevant authorities having jurisdiction, which include, but not limited to, all requirements, site administration and regulations, safety, health and environmental regulations, and regulation and planning of the project location with its sectors.

B. The Contractor shall take all precautions necessary to protect persons and property on or off site from injury or damage resulting from work under this Contract.

C. Failure to comply with any of the regulations or requirements shall be considered a breach of Contract by the Contractor and may result in termination of the Contract by the Employer. Nevertheless, should the Contractor fail to comply with such:
   1. The Engineer may suspend the Works or part of the Works until the Contractor has taken necessary steps, to the satisfaction of the Engineer, to comply with the regulations or requirements.
   2. The Engineer may suspend any interim payment certificate until such time as the Contractor has rectified the breach or breaches to the satisfaction of the Engineer. No interest shall be paid on the suspended payments.
   3. The Employer may, following written notice to the Contractor, carry out himself or arrange for another contractor to carry out such measures as he considers appropriate on behalf of the Contractor. Any such actions by the Employer shall not affect or diminish the Contractor's obligations or responsibilities under the Contract.
   4. The Engineer may, following written notice to the Contractor, deduct from payments to the Contractor an amount of money as a penalty for each breach of any regulation or requirement. Such notice shall specify the nature of the failure or failures, and the period after the date of the notice within which the Contractor shall remedy each failure.

D. In the event of the Employer or Engineer taking action based on the above, the Contractor shall not be entitled to any additional costs or extension to the Contract Completion Date.

E. All costs incurred by the Employer pursuant to the above, and the deductions from payments imposed on the Contractor by the Engineer shall be deducted from amounts otherwise due to the Contractor.

1.3 RELATED ITEMS

A. General Requirements: Contractor's use of site, administrative requirements for field engineering, and execution requirements for cleaning.

1.4 STANDARDS AND REGULATIONS

A. In addition to what is stated in this specification section, all temporary utilities, temporary controls and construction facilities shall comply with relevant authorities' standards and regulations for "Site Administration and Rules", "Safety, Health and Environmental Regulations", and all other local authorities' standards and regulations.

B. Moreover, the Contractor is responsible to perform all the necessary process, regarding all temporary services, with all relevant authorities, and shall pay all installation and maintenance fees.

1.5 ELECTRICITY

A. Provide, maintain and pay for power service required for the works from time of project mobilization until handing over.

B. Provide power outlets for construction operations, with branch wiring and distribution boxes located as required.

C. Provide main service disconnect and over-current protection at convenient location.

D. Permanent convenience receptacles may not be utilized during construction.

E. Provide adequate distribution equipment, wiring and outlets to provide single phase branch circuits for power and lighting.
   1. Provide 20 ampere duplex outlets, single phase circuits for power tools for each active work area.
   2. Provide 20 ampere, single phase branch circuits for lighting.

1.6 LIGHTING FOR CONSTRUCTION PURPOSES

A. Provide and maintain incandescent lighting for construction operations to achieve acceptable lighting level.

B. Provide and maintain lighting to exterior staging and storage areas after dark for security purposes.

C. Provide and maintain lighting to interior work areas after dark for security purposes.

D. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails and lamps as required.

E. Maintain lighting and provide routine repairs.

F. Permanent lighting shall not be utilized during construction.

1.7 SITE LIGHTING

A. The Contractor shall install temporary site lighting including but not restricted to perimeter fence, name boards, parking areas and for site safety to the satisfaction of the Engineer and the approval of Statutory Authorities.

1.8 HEATING

A. Existing facilities, if any, shall not be used, unless otherwise directed by the Engineer.

B. Provide and pay for heating devices and heat as needed to maintain specified conditions for construction operations.

C. Prior to operation of permanent equipment for temporary heating purposes, verify installation is approved for operation, equipment is lubricated and filters are in place. Provide and pay for operation, maintenance, and regular replacement of filters and worn or consumed parts.

D. Unless otherwise directed by the Engineer or indicated in "Product" part in each individual specification sections, maintain minimum ambient temperature of 10ºC in areas where construction is in progress.

1.9 COOLING

A. Existing facilities, if any, shall not be used, unless otherwise directed by the Engineer.

B. Provide and pay for cooling devices and cooling as needed to maintain specified conditions for construction operations.

C. Prior to operation of permanent equipment for temporary cooling purposes, verify installation is approved for operation, equipment is lubricated and filters are in place. Provide and pay for operation, maintenance, and regular replacement of filters and worn or consumed parts.

1.10 VENTILATION

A. Ventilate enclosed areas to achieve curing of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

1.11 TELEPHONE SERVICE

A. Provide, maintain and pay for telephone service to field office and Engineer's field office from time of project mobilization until completion of the works.

1.12 FACSIMILE SERVICE

A. Provide, maintain and pay for facsimile service and dedicated telephone line to field office and Engineer's field office from time of project mobilization until completion of the works.

1.13 WATER SERVICE

A. Provide, maintain and pay for suitable quality water service required for construction operations and all purposes from time of project mobilization until completion of the works.

B. Extend branch piping with outlets located so water is available by hoses with threaded connections.

C. Make available clean and hygiene potable water for the use of personnel on site.

D. Test to BS 3148 when instructed.

1.14 SANITARY FACILITIES

A. Provide and maintain required facilities and enclosures. Provide from time of project mobilization until completion of the works.

B. Sanitary facilities include temporary well aerated toilets, wash facilities and drinking water fixtures. Comply with regulations and health codes for the type, number, location, operation, and maintenance of fixtures and facilities.

1. Provide toilet tissue, paper towels, paper cups and similar disposable materials for each facility.
2. Provide covered waste containers for used material.
3. Use of the Owner’s toilet facilities will not be permitted.
4. Install self-contained toilet units. Shield toilets to ensure privacy Use of pittype privies will not be permitted.
5. Provide separate facilities for male and female personnel.
6. Provide proper sanitation by connecting to the main sewage system.

1.15 BARRIERS

A. Provide barriers to prevent unauthorized entry to construction areas and to protect facilities and adjacent properties from damage from construction operations.

B. Provide barricades and covered walkways required by governing authorities for public rights-of-way and for public access to any existing adjacent property.

C. Protect non-owned vehicular traffic, stored materials, site and structures from damage.

D. Provide protection for plants designated to remain. Replace damaged plants.

1.16 ENCLOSURES

A. Exterior Enclosures:
   1. Provide temporary scaffolding with approved screens to safeguard the public from dust and fallout as per Engineer Requirement.
   2. Provide temporary insulated weather tight closure of exterior openings to accommodate acceptable working conditions and protection for products, to allow for temporary heating and maintenance of required ambient temperatures identified in individual specification sections, and to prevent entry of unauthorized persons. Provide access doors with self-closing hardware and locks.
   3. Provide temporary roofing to the satisfaction of the Engineer.

B. Interior Enclosures:
   1. Provide temporary partitions and ceilings as directed and to the satisfaction of the Engineer, to separate work areas from Owner occupied areas, to prevent penetration of dust and moisture into Owner occupied areas, and to prevent damage to finished and completed work.
   2. Construction: Framing and reinforced polyethylene, plywood or gypsum board sheet materials with closed joints and sealed edges at intersections with existing surfaces:
      a. Insulated to RSI Standards.
      b. STC rating of 35 in accordance with ASTM E90.
      c. Maximum flame spread rating of 25 in accordance with ASTM E84.
   3. Paint surfaces exposed to view from Owner occupied areas.

1.17 FENCES AND GATES

A. Maintain the site from unauthorized entrant by maintaining all necessary temporary fences and gates around and within the site provided by the Employer.

B. Maintain fencing, gates and other temporary items as long as required for safe and proper completion of work, promptly repair or replace in the event of loss or damage.

C. Maintain electrical fixtures including wires, boxes, lamps and switches as directed by the Engineer.

D. All materials shall be of adequate strength and suitable for use intended and shall be non-staining and non-corrosive.

E. Upon completion of the works, remove fences and gates to areas indicated by the Employer and make good the area to the satisfaction of the Engineer.

1.18 SECURITY

A. Security Program:
   1. Protect Work, existing premises and Owner's operations from theft, vandalism and unauthorized entry.
   2. Initiate program at project mobilization.
   3. Maintain program throughout construction period until Owner occupancy or when directed by the Engineer.

B. Entry Control:
   1. Restrict entrance of persons and vehicles into Project site and facilities.
   2. Allow entrance only to authorized persons with proper identification.
   3. Maintain log of workers and visitors, make available to Owner on request.
   4. Control entrance of persons and vehicles related to Owner's operations.

C. Personnel Identification:
   1. Provide identification badge to each person authorized to enter premises.
   2. Badge to Include: Personal photograph, name and assigned number, Contractor name, and Sub-Contractor name (if any).
   3. Maintain list of accredited persons, submit copy to Owner on request.
   4. Require return of badges at expiration of their employment on the Work.

D. Security Service: Employ uniformed guard service to provide watchpersons at site twenty four hours a day, seven days a week.

E. Restrictions: Do not allow cameras on site or photographs taken except by written approval of Owner.

1.19 TRAFFIC SAFETY AND REGULATION

A. General:
   1. The Contractor shall provide, erect and maintain such traffic signs, traffic control signals and such other measures as may be required by the Construction of the Works to the satisfaction of the Engineer.
   2. The Contractor shall not commence any work which affects public roads until all the traffic safety measures necessitated by the work are fully operational.
   3. The Contractor shall keep clean and legible at all times all traffic signs, lamps, barriers and traffic control signals and he shall position, cover or remove them as required by the progress of the Works.

B. Signs, Signals and Devices:
   1. Post Mounted and Wall Mounted Traffic Control and Informational Signs: As approved by authority having jurisdiction.
   2. Traffic Control Signals: As approved by local jurisdictions.
   3. Traffic Cones and Drums, Flares and Lights: As approved by authority having jurisdiction.
   4. Flag Person Equipment: As required by authority having jurisdiction.

C. Traffic Signs and Signals:
   1. Provide signs at approaches to site, on site, at crossroads, detours, parking areas and elsewhere as needed to direct construction and affected public traffic.
   2. Provide, operate and maintain traffic control signals to direct and maintain orderly flow of traffic in areas under Contractor's control and areas affected by Contractor's operations.
   3. Relocate as Work progresses, to maintain effective traffic control.

D. Flag Persons: Provide trained and equipped flag persons to regulate traffic when construction operations or traffic encroach on public traffic lanes.

E. Flares and Lights: Use flares and lights during hours of low visibility to delineate traffic lanes and to guide traffic.

F. Haul Routes:
1. Consult with authority having jurisdiction, establish public thoroughfares to be used for haul routes and site access.
2. Confine construction traffic to designated haul routes.
3. Provide traffic control at critical areas of haul routes to regulate traffic and to minimize interference with public traffic.

G. Mud:
1. The wheels of all vehicles shall be well washed before being allowed to leave the Site; lay-down area or any other area which the Contractor is utilizing for the purposes of this Contract.
2. Any mud, which is deposited outside the site boundary, is to be removed immediately, and the whole area shall be thoroughly cleaned.

H. Removal:
1. Remove equipment and devices at Substantial Completion or when directed by the Engineer.
2. Remove post settings to depth of 600 mm.
3. Repair damage caused by installation.

1.20 WATER CONTROL

A. Grade site to drain. Maintain excavations free of water. Provide, operate and maintain pumping equipment.

B. Protect site from pudding or running water.

1.21 DUST CONTROL

A. Execute Work by methods to minimize raising dust from construction operations.

B. Provide positive means to prevent air-borne dust from dispersing into atmosphere.

1.22 EROSION AND SEDIMENT CONTROL

A. Plan and execute construction by methods to control surface drainage from cuts and fills, from borrow and waste disposal areas. Prevent erosion and sedimentation.

B. Minimize surface area of bare soil exposed at one time.

C. Provide temporary measures including berms, dikes and drains, and other devices to prevent water flow.

D. Construct fill and waste areas by selective placement to avoid erosive surface silts or clays.

E. Periodically inspect earthwork to detect evidence of erosion and sedimentation; promptly apply corrective measures.

1.23 NOISE CONTROL

A. Provide methods, means and facilities to minimize noise produced by construction operations.

1.24 PEST CONTROL

A. Provide methods, means and facilities to prevent pests and insects from damaging the Work and entering facility.

1.25 POLLUTION CONTROL

A. Provide methods, means and facilities to prevent contamination of soil, water and atmosphere from discharge of noxious, toxic substances and pollutants produced by construction operations.

B. Comply with pollution and environmental control requirements of authorities having jurisdiction.

1.26 RODENT CONTROL

A. Provide methods, means and facilities to prevent rodents from accessing or invading premises.

1.27 FIRST AID FACILITIES

A. The Contractor shall provide and maintain on site first aid facilities throughout the Contract period to the approval of the Engineer.

1.28 PARKING

A. Construct temporary paved surface covered parking areas to accommodate Employer, Engineer and Supervision Consultant personnel. Do not use these designated areas of parking facilities used by Employer, Engineer and Supervision Consultant personnel.

B. Locate as indicated on Drawings or as approved by the Engineer.

C. When site space is not adequate, provide additional off-site parking.

D. Use of designated existing on-site streets and driveways used for construction traffic is not permitted. Tracked vehicles not allowed on paved areas.

E. Do not allow heavy vehicles or construction equipment in parking areas.

F. Do not allow vehicle parking on existing pavement.

G. Permanent Pavements and Parking Facilities:
   1. Prior to Substantial Completion, bases for permanent roads and parking areas may be used for construction traffic.
   2. Avoid traffic loading beyond paving design capacity. Tracked vehicles not allowed.

3. Use of permanent parking structures is not permitted.

H. Maintenance:
1. Maintain traffic and parking areas in sound condition free of excavated material, construction equipment, products, mud, etc.
2. Maintain paved areas used for construction; promptly repair breaks, potholes, low areas, standing water and other deficiencies, to maintain paving and drainage in original or specified condition.

I. Removal and Repair:
1. Remove temporary materials and construction at Substantial Completion.
2. Remove underground work and compacted materials to depth of 600 mm; fill and grade site as specified.
3. Repair existing and permanent facilities damaged by use, to original and specified condition respectively.

1.29 PROGRESS CLEANING AND WASTE REMOVAL

A. Maintain areas free of waste materials, debris and rubbish; periodically collect, remove and dispose them off-site. Maintain site in clean and orderly condition.

B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces and other closed or remote spaces, prior to enclosing spaces.

C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.

D. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

1.30 PROJECT IDENTIFICATION

A. Project Identification Sign:
1. Painted sign of construction, design and location as shown on the Drawings or as directed by the Engineer.
2. Unless otherwise indicated on drawings or directed by the Engineer, the content of the Project Identification Sign shall include the following:
a. Project number and title, logo and name of Owner as indicated on Contract Documents.
b. Names and titles of authorities.
c. Names and titles of Engineer and Supervision Consultants.
d. Name of Prime Contractor and major Sub-Contractors.

B. Project Informational Signs: Of same colors and lettering as Project Identification Sign, or standard products; size lettering for legibility at 30 m distance.
1. Provide sign at each field office, storage shed and directional signs to direct traffic into and within site. Relocate as Work progress requires.
2. Provide local relevant authorities' directional traffic signs to and within site.
3. No other signs are allowed without Owner permission, except those required by law.

C. Design sign and structure to withstand 160 km/hr wind velocity.

D. Sign Painter: Experienced as professional sign painter for minimum five years.

E. Finishes and Painting: Adequate to withstand weathering, fading and chipping for duration of construction.

F. Submit for Engineer’s approval, shop drawings showing content, layout, lettering, color, foundation, structure and all sizes and dimensions.

G. Sign Materials: Unless otherwise indicated on drawings, or directed by the Engineer:
   1. Structure and Framing: Wood or metal, structurally adequate.
   2. Sign Surfaces: Exterior grade plywood with medium density overlay, minimum 19 mm thick, standard large sizes to minimize joints.
   3. Rough Hardware: Galvanized.
   4. Paint and Primers: Exterior quality, two coats; sign background of color as selected by the Engineer.
   5. Lettering: Exterior quality paint, colors as selected by the Engineer.

H. Installation:
   1. Install project identification sign at designated location within 15 days after Contract implementation commencement date.
   2. Erect supports and framing on secure foundation, rigidly braced and framed To resist wind loadings.
   3. Install sign surface plumb and level, with butt joints. Anchor securely.
   4. Paint exposed surfaces of sign, supports and framing.

I. Maintenance: Maintain signs and supports clean, repair deterioration and damage.

J. Removal: Remove signs, framing, supports and foundations at completion of Project and restore area.

1.31 FIELD OFFICES AND SHEDS

A. Scope:
   1. This section specifies the temporary field offices and sheds, services and facilities required in the construction, completion and maintenance of works.
   2. Any proposed change in location or relocation of offices must be preceded by submission for Engineer's approval of a drawing, indicating such change.

B. Offices: Weather tight, with lighting, electrical outlets, heating, cooling and ventilating equipment, and equipped with sturdy furniture, drawing rack and drawing display table.

C. Provide separate private offices with security fencing around the perimeter, similarly equipped and furnished, for use of the Engineer.

D. Offices shall include the main structure, sheltered car park, temporary water tanks and temporary sewage collection and treatment systems.

E. Locate offices and sheds at minimum required distance from structures.

F. Prepare and submit for Engineer's approval an architectural layout plan of site offices.

G. Do not use permanent or existing facilities for field offices or for storage unless otherwise agreed with Owner.

H. Construction: Portable or mobile buildings, or buildings constructed with floors raised above ground, securely fixed to foundations with steps and landings at entrance doors.
   1. Construction: Structurally sound, secure and weathertight enclosures. Maintain during progress of Work; remove at completion of Work.
   2. Temperature Transmission Resistance of Floors, Walls and Ceilings: Compatible with occupancy and storage requirements.
   3. Exterior Materials: Weather resistant; color as selected by the Engineer.
   4. Interior Materials in Offices: Sheet type materials for walls and ceilings, prefinished or painted; resilient floors and bases.
   5. Lighting for Offices: 538 lx at desktop height, exterior lighting at each entrance door.
   6. Fire Extinguishers: Appropriate type fire extinguisher at each office and each torage area.
   7. Interior Materials in Storage Sheds: As required to provide specified conditions for storage of products.

I. Environmental Control:
   1. Heating, Cooling and Ventilating for Offices: Heat pump split unit systems to maintain 20ºC heating and 23ºC cooling.
   2. Storage Spaces: Heating and ventilation as needed to maintain products in accordance with Contract Documents; and lighting for maintenance and inspection of products.

J. Contractor’s Site Office Schedule:
   1. The site area is limited. The Contractor shall make arrangement to provide and maintain throughout the period of construction in a convenient location approved by the Engineer, adequate heated and air conditioned office accommodation for the Contractor’s use and the use of his Sub-Contractors. Such accommodation shall include proper messing and sanitary facilities and shall be provided with suitable fire fighting facilities and adequate means of escape in case of fire, all to the approval of the Engineer.
   2. The Contractor shall not allow any of his employees or those of his Sub-Contractors to maintain any temporary or permanent living quarters within the construction site.

K. Engineer’s and Employer’s Site Offices Accommodation and Equipment Schedule: The Contractor shall erect, equip, furnish, maintain, service and ensure for the entire construction period until at least the issue of the Taking Over Certificate, or such time as the Engineer may direct, the Engineer’s and Employer Site Offices with the following characteristics, tools, instruments, fire means, equipment and furniture, all to the satisfaction of the Engineer:
   1. Site Offices:
      a. 1 general reception and secretary's room, approximate size [3 x 3m].
      b. 1 conference room, approximate size [3 x 6m].
      c. 2 office rooms, approximate size [3 x 4m] each.
      d. 1 store room, approximate size [3 x 3m].

e. 1 kitchen and pantry, approximate size [3 x 3m].
f. 2 toilets and lavatories, approximate size [1.5 x 1.5m] each.

2. Site Offices Furniture and Equipment:
   a. General Reception and Secretary's Room:
      1) 1 secretary's desk and swivel chair.
      2) 2 large lockable sheet filing cabinets.
      3) 1 reference table.
      4) 6 office chairs.
      5) 2 armchairs with 1 circular table in between.
      6) 6 calculators.
      7) 2 pin boards.
      8) 2 shelves.
      9) 2 waste baskets.
      10) 1 digital camera, Canon or similar, minimum 10 mega pixels, with 1 GB memory stick and USB cable.
      11) 1 plain paper modern fax machine including all consumables throughout the Contract duration.
      12) 1 computer (as defined hereinafter).
      13) 1 HP Laser Jet printer with A4 papers.
      14) 1 colored photocopying machine with built-in scanner, size A3 & A4 similar to Xerox Work Center 7132, including all consumables and photocopying papers throughout the Contract duration.
   b. Conference Room:
      1) 1 conference table for 10 people.
      2) 10 chairs.
      3) 2 pin boards.
      4) 2 shelves.
      5) 2 waste baskets.
      6) 1 reference table.
      7) 1 projector with projection screen.
   c. Office Rooms: Each office room shall comprise:
      1) 2 desks with lockable drawers and swivel chairs.
      2) 2 lockable steel filing cabinets.
      3) 4 office chairs.
      4) 1 drawing hanger for 10 sets.
      5) 2 shelves.
      6) 2 pin boards.
      7) 2 waste paper baskets.
      8) 1 reference table.
      9) 1 computer (as defined hereinafter).
   d. Store Room:
      1) Shelving units.
      2) Drawing hangers and racks.
      3) 1 reference table.
   e. Kitchen and Pantry:
      1) 1 table for 6 people.
      2) 6 polypropylene chairs.
      3) 1 refrigerator 14 cu. ft. capacity.
      4) 1 coffee machine.
      5) 1 water filter and 20 liters water cooler/hot/cold.

6) 2 electric boiling rings.
7) 1 microwave.
8) 1 stainless steel sink and drainer.
9) 1 heat resistant worktop.
10) 1 set of storage cupboards.
11) 1 set of crockery and cutlery for each member of the staff.
12) 1 large wastebasket with cover.
13) All necessary consumables throughout the Contract duration.

f. Toilets and Lavatories: Each toilet and lavatory shall comprise:
1) 1 w.c. suite.
2) 1 hose bib.
3) 1 toilet roll holder.
4) 1 wash hand basin.
5) 1 mirror with shelf.
6) 1 soap dispenser.
7) 1 automatic electric hand dryer or 1 paper towel holder.
8) 1 wastebasket with cover.
9) All necessary consumables throughout the Contract duration.

3. Site Offices Services: The Contractor shall provide and maintain throughout the whole Contract duration, the following minimum services:
a. Heating and air-conditioning.
b. Electric power supply and lighting installations.
c. Water supply.
d. Drainage system.
e. Fire fighting and fire alarm systems.
f. Cleaning facilities and general attendance with necessary personnel.
g. Telephone Service: Four telephone lines (two mobile cellular lines with devices, and two fixed telephone lines linked by a PBX with telephone answering machine and 20 internal extensions) including cost of installation, maintenance and all rental and local call charges.
h. Facsimile Service: One fixed telephone line shall be dedicated to facsimile machine and shall include direct dialing facility.
i. Computer System:
1) 1 NT server, latest version, with three linked computers, each equipped with the latest Processor Intel, minimum 3.2 GHz, 2.0 GB of Ram, and 150 GB hard disk capacity; video local bus; 256 MB VGA; 56x CD drive (Read/Write); 16x DVD drive (Read/Write); internet and e-mail service modem; English-Arabic keyboard; SVGA Flat, non-interlaced, low power, low radiation 19 inch rotating colored monitor; necessary ports; optical mouse; and antistatic dust covers.
2) One latest laptop.
3) Software: License for latest version of the following:
a) Windows XP and Microsoft Office XP.
b) AutoCAD.
c) Primavera.
d) Adobe Acrobat Reader/Writer Professional.
4) Internet Connection: Minimum speed 512k.
5) Uninterruptible power supply (UPS) for all above equipment with minimum one-hour backup batteries.
6) Computer table and chair;

7) All required and necessary cabling.
8) All consumables with all stationery and offices supplies throughout the Contract duration.
9) Maintenance for all equipment throughout Contract duration.

j. At the end of the project, all the above equipment shall remain the property of the Contractor.

L. Storage Areas and Sheds: The Contractor shall provide on site weatherproof sheds and storage facilities for the materials intended for the Works. The Contractor shall maintain and remove the same on completion of the Works.

1. Size to storage requirements for products of individual specification sections, allowing for access, and orderly provision for maintenance and for inspection of products.

M. Preparation:

1. Fill and grade sites for temporary structures, facilities and controls.
2. Slope for drainage away from site offices.

N. Installation:

1. Install office spaces ready for occupancy 15 days after Contract implementation commencement date.
2. Parking: Six hard surfaced covered parking spaces for use by Engineer, connected to office by hard surfaced walk.
3. Employee Residential Occupancy: Not allowed on Owner's property.

O. Maintenance, Cleaning and Attendance upon Offices Accommodation:

1. Provide daily cleaning and maintenance for offices and storage areas.
2. Provide full time attendance of the Engineer’s site office accommodation including one cleaner, one tea boy and one messenger. All to attend upon the requirements of the staff. The cost of cleaning materials and consumable such as, paper towels, paper tissues, toilet rolls, cookery and cutlery, tea, coffee, sugar, etc. shall be paid for by the Contractor. The services of the tea boy and messenger, the provision of consumables and cleaning materials and the maintenance of the site office shall be extended to cover the construction duration until completion. Consumables shall be supplied and delivered to the site at regular intervals as directed by the Engineer.
3. Maintain approach walks free of mud, dust, water, etc.

1.32 VEHICLES

A. Not Applicable.

1.33 VEHICULAR ACCESS

A. Construct temporary access roads from public thoroughfares to serve construction area, of width and load bearing capacity to accommodate unimpeded traffic for construction purposes.

B. Construct temporary ditches and culverts to allow unimpeded drainage.

C. Extend and relocate vehicular access as Work progress requires, provide detours as

necessary for unimpeded traffic flow.

D. Locate as indicated on Drawings, or where directed by the Engineer.

E. Provide unimpeded access for emergency vehicles. Maintain 6 m wide driveways with turning space between and around combustible materials.

F. Provide and maintain access to fire hydrants and control valves free of obstructions.

G. Unless otherwise directed by the Engineer, do not use existing on-site roads for construction traffic.

1.34 PLANT AND SMALL TOOLS

A. The Contractor shall provide all constructional plant and small tools necessary for the proper execution of the Works.

1.35 SCAFFOLDING AND HOISTING

A. The Contractor shall provide, erect and maintain proper and adequate scaffolding, staging, stairs, ladders, chutes, materials hoist, special rigging and the like required for the Work and shall comply with all requests, safety instructions, etc., issued by the Engineer relating thereto. The Contractor shall provide all necessary guards, signals, safety devices and the like required for safety of operations including suitable runways from the hoists to each level and roof.

B. The Contractor shall also provide, erect and maintain personnel hoist adequate to transport all personnel of Employer, Engineer/Supervision Consultant and Contractor.

C. Material hoists shall not be used for transporting personnel and only skilled personnel shall be used for the operation and maintenance of hoists. The construction, maintenance and operation of hoists shall conform to the applicable requirements of the applicable Codes in force. Use of permanent lifts equipment (if any) for transporting materials or personnel will not be allowed except with prior written permission of the Engineer.

D. Location and means of operation of hoist shall be subject to the Engineer’s approval and shall in no way hinder the progress of the work and shall not relieve the Contractor from his duties and obligations under the Contract.

E. Scaffolding shall be of tubular steel construction and designed in accordance with the requirements of BS 5973 and BS 5974.

F. Hoists, chute, scaffolding and the like shall be so constructed as to prevent damage, staining or marring of the Permanent Work. No materials, rubbish or debris shall be permitted to drop free, but shall be removed by use of hoists or fully enclosed rubbish chutes.

G. Provide suitable safety railings for stairs, ladders, ramps, etc.

H. On completion of the Work, clear away and remove all scaffolding and hoisting.

1.36 REMOVAL OF UTILITIES, FACILITIES AND CONTROLS

A. At the end of the entire project, remove temporary utilities, materials, equipment, facilities and controls.
   1. Remove offices with foundations, utility services and debris.
   2. Remove underground installations to minimum depth of 600 mm, unless otherwise indicated on Drawings.
   3. Restore areas and make good all disturbed surfaces.
   4. Restore existing facilities used during construction to original condition. Restore permanent facilities used during construction to specified condition.
   5. Clean and repair damage caused by installation or use of temporary work.

END OF SECTION

SECTION 01600

PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 SCOPE

A. This section specifies the General Requirements for:
1. Products.
2. Product delivery requirements.
3. Product storage and handling requirements.
4. Product options.
5. Product substitution procedures.
6. Protection.
7. Equipment electrical characteristics and components.

B. The requirements of this section are augmented by specific clauses specifying quality throughout all sections of the Specification.

1.2 PERFORMANCE AND STANDARDS

A. Neither asbestos containing materials (ACM) nor chromate copper arsenate (CCA) treated timber shall be used in the project.

B. All products shall perform as specified and the handling, transportation and storage thereof shall be as specified and such that the ultimate performance of the products shall in no way be impaired.

C. The quality of products and reference to Standards and Codes of Practice is covered in the "Administrative Requirements" Section.

D. Where, in the course of the Project, materials, products, assemblies, equipment or techniques, are required which are not named, definitively described or implied in the Specification, they shall nonetheless conform to all relevant both as regards Materials and Workmanship and quality, suitability and performance which are not less than implicit in this Specification to the satisfaction of the Engineer.

E. The Contractor shall at all time use his best endeavors to produce materials and work of a consistent and high quality and standard, whether or not such standard is identifiable in the Specification.

F. The Contractor shall abide by the Engineer’s interpretation of the Specification and shall comply with his decisions regarding the quality of Materials and Workmanship.

1.3 RELATED ITEMS

A. General Requirements: Administrative regulatory requirements, submittal procedures, and execution requirements for warranties and bonds.

1.4 SUBMITTALS

A. General Requirements: Submittal procedures.

1.5 PRODUCTS

A. Furnish products of qualified manufacturers suitable for intended use. Furnish products of each type by single manufacturer unless specified otherwise.

B. Do not use materials and equipment removed from existing premises, except as specifically permitted by Contract Documents.

C. Furnish interchangeable components from same manufacturer for components being replaced.

1.6 PRODUCT DELIVERY REQUIREMENTS

A. Transport and handle products in accordance with manufacturer's instructions.

B. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct and products are undamaged.

C. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

1.7 PRODUCT STORAGE AND HANDLING REQUIREMENTS

A. Store and protect products in accordance with manufacturers' instructions.

B. Store with seals and labels intact and legible.

C. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.

D. For exterior storage of fabricated products, place on sloped supports above ground. E. Provide off-site storage and protection when site does not permit on-site storage or protection.

F. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

G. Store loose granular materials on solid flat surfaces in well-drained area. Prevent mixing with foreign matter.

H. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

I. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

1.8 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Any product meeting those standards, equivalent standards, or description.

B. Products Specified by Naming One or More Manufacturers: Products of one of manufacturers named and meeting specifications, no options or substitutions allowed.

C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit request for substitution for any manufacturer not named in accordance with the following article.

1.9 PRODUCT SUBSTITUTION PROCEDURES

A. The Engineer will consider requests for Substitutions only within 30 days after Contract implementation commencement date.

B. Substitutions may be considered when a product becomes unavailable through no fault of Contractor.

C. Document each request with complete data substantiating compliance of proposed Substitution with Contract Documents.

D. A request constitutes a representation that Contractor:
   1. Has investigated proposed product and determined that it meets or exceeds quality level of specified product.
   2. Will provide same warranty for Substitution as for specified product.
   3. Will coordinate installation and make changes to other Work which may be required for the Work to be complete with no additional cost to Owner.
   4. Waives claims for additional costs or time extension which may subsequently become apparent.
   5. Will reimburse Owner and Engineer for review or redesign services associated with re-approval by authorities having jurisdiction.

E. Substitutions will not be considered when they are indicated or implied on Shop Drawing or Product Data submittals, without separate written request, or when acceptance will require revision to Contract Documents.

F. Substitution Submittal Procedure:
   1. Submit three copies of request for Substitution for consideration. Limit each request to one proposed Substitution.
   2. Submit Shop Drawings, Product Data, and certified test results attesting to proposed product equivalence. Burden of proof is on proposer.
   3. Engineer will notify Contractor in writing of decision to accept or reject request.

1.10 PROTECTION

A. The Contractor shall provide and maintain until practical completion all necessary protection to be installed to the work and equipment to prevent damage or deterioration.

PART 2 PRODUCTS

2.1 EQUIPMENT ELECTRICAL CHARACTERISTICS AND COMPONENTS

A. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Include lugs for terminal box.

B. Cord and Plug: Furnish minimum 2 m cord and plug including grounding connector for connection to electric wiring system. Cord of longer length is specified in individual specification sections.

END OF SECTION

SECTION 01700

EXECUTION REQUIREMENTS

PART 1 GENERAL

1.1 SECTION INCLUDES

A. Closeout procedures.
B. Cleaning.
C. Starting of systems.
D. Demonstration and instructions.
E. Testing, adjusting and balancing.
F. Protecting installed construction.
G. Project record documents.
H. Operation and maintenance data.
I. Manual for materials and finishes.
J. Manual for equipment and systems.
K. Instruction of Employer personnel.
L. Spare parts and maintenance products.
M. Product warranties and product bonds.
N. Maintenance service.
O. Protection and making good.

1.2 CLOSEOUT PROCEDURES

A. Submit written certification that Contract Documents have been reviewed, Work has been inspected, and that Work is complete in accordance with Contract Documents and ready for Engineer's review.

B. Provide submittals to the Engineer required by authorities having jurisdiction.

C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments and sum remaining due.

D. Owner will occupy all or portions of the completed works as directed.

1.3 CLEANING

A. General:
1. Execute cleaning during progress of the work and at completion of the work.
2. If the Contractor fails to clean up during or at completion of work, the Employer may do so, and the cost thereof shall be charged to the Contractor.
3. Conduct cleaning and disposal operations to comply with codes, ordinances, and anti-pollution laws.
4. Use only those cleaning materials which will not create hazards to health or property and which will not damage surfaces.
5. Use only those cleaning materials and methods recommended by manufacturer of the surface material to be cleaned.

B. Cleaning during Construction:

1. Execute periodic cleaning to keep the work, the site and adjacent properties free from accumulations of waste material, rubbish and windblown debris, resulting from construction operations.
2. Provide on-site containers for the collection of waste materials, debris, etc.
3. Remove waste materials, debris and rubbish from the site periodically and dispose off at legal disposal areas away from the site.

C. Dust Control:

1. Clean interior spaces to the start of finish painting and continue cleaning on and as-needed basis until painting is finished.
2. Schedule operations so that dust and other contaminants resulting from cleaning process will not fall on wet or newly-coated surfaces.

D. Final Cleaning:

1. Employ skilled workmen or specialized firm for final cleaning.
2. Remove grease, mastic, adhesives, dust, dirt, stains, fingerprints, labels and other foreign materials from sight-exposed interior and exterior surfaces.
3. Clean interior and exterior glass, and surfaces exposed to view; remove temporary labels, stains and foreign substances, wash and shine glazing, and polish transparent and glossy surfaces.
4. Wax and polish finish floors.
5. Clean all hardware with cleaning materials appropriate to surface and material being cleaned.
6. Clean equipment and fixtures to sanitary condition with cleaning materials appropriate to surface and material being cleaned.
7. Ventilating System: Replace filters of operating equipment; clean ducts, blowers and coils if units were operated without filters during construction.
8. Clean debris from roofs, gutters, downspouts, and drainage systems.
9. Clean site; sweep paved areas, rake clean landscaped surfaces.
10. Comply with all special cleaning instructions contained in the specifications.
11. Remove temporary services, construction equipment, tools and construction facilities, mock-ups, temporary structures, surplus materials, debris, waste, and rubbish from site.
12. Put site in neat, orderly condition, ready for use. Leave all spaces clean and free from debris.
13. Prior to final completion, conduct an inspection of sight-exposed interior and exterior surfaces, and all work areas, to verify that the entire work is clean.

1.4 STARTING OF SYSTEMS

A. Coordinate schedule for start-up of various equipment and systems.

B. Notify the Engineer seven days prior to start-up of each item, unless otherwise specified in individual specification sections.

C. Verify each piece of equipment/system has been checked for proper lubrication, drive rotation, belt tension, control sequence and for conditions which may cause damage.

D. Verify tests, meter readings and specified electrical characteristics agree with those required by equipment or system manufacturer.

E. Verify that wiring and support components for equipment are complete and tested.

F. Execute start-up under supervision of applicable manufacturer's representative and Contractors' personnel in accordance with manufacturers' instructions.

G. When specified in individual specification sections, require manufacturer to provide authorized representative to be present at site to inspect, check and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in operation.

H. Submit a written report as specified in the "Submittal Procedures" Section of the General Requirements, that equipment or system has been properly installed and is functioning correctly.

1.5 DEMONSTRATION AND INSTRUCTIONS

A. Demonstrate operation and maintenance of products to Owner's personnel two weeks prior to date of substantial completion and/or final inspection.

B. Demonstrate Project equipment and instruct in a classroom environment located at site and instructed by qualified applicable personnel or manufacturer's representative who is knowledgeable about the Project.

C. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.

D. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.

E. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at agreed time and at equipment location.

F. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

G. Required instruction time for each item of equipment and system is specified in individual sections.

1.6 TESTING, ADJUSTING AND BALANCING

A. Contractor will appoint, employ and pay for services of an independent firm approved by the Engineer, to perform testing, adjusting and balancing.

B. The independent firm will perform services stated in the Specifications

C. Reports will be submitted by the independent firm to the Engineer indicating observations and results of tests and indicating compliance or non-compliance with requirements of Contract Documents.

1.7 PROTECTING INSTALLED CONSTRUCTION

A. Protect installed Work and provide special protection where specified in individual specification sections.

B. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.

C. Provide protective coverings at walls, projections, jambs, sills and soffit of openings.

D. Protect floors, stairs and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects by protecting with durable sheet materials.

E. Prohibit traffic or storage upon waterproofed or roofed surfaces. When traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.

F. Prohibit traffic from landscaped areas.

1.8 PROJECT RECORD DOCUMENTS

A. Maintain on site one set of the following record documents; record actual revisions to the Work:
   1. Drawings.
   2. Specifications.
   3. Addenda.
   4. Change Orders and other modifications to the Contract.
   5. Reviewed Shop Drawings, Product Data and Samples.
   6. Manufacturer's instruction for assembly, installation and adjusting.

B. Ensure entries are complete and accurate enabling future reference by Owner.

C. Store record documents separate from documents used for construction.

D. Record information concurrent with construction progress, not less than weekly.

E. Specifications: Legibly mark and record at each product section description of actual products installed, including the following:
   1. Manufacturer's name and product model and number.
   2. Product substitutions or alternates utilized.
   3. Changes made by Addenda and modifications.

F. Record Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
   1. Measured depths of foundations in relation to finish floor datum.
   2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
   3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
   4. Field changes of dimension and detail.
   5. Details not on original Contract drawings.

G. Submit documents to the Engineer with claim for final Application for Payment.

1.9 OPERATION AND MAINTENANCE DATA

A. Format:
1. Prepare instructions and data by personnel experienced in maintenance and operation of described projects.
2. Prepare data in the form of an instructional manual.
3. Submit data bound in A4 text pages.
4. Binders: Commercial quality binders with durable plastic covers. When multiple binders are used, correlate data into related consistent groupings.
5. Cover: Identify each binder with printed title "Operation and Maintenance Instructions", title of project and subject matter of binder when multiple binders are required.
6. Internally subdivide binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.
7. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
8. Contents: Prepare Table of Contents for each volume, with each product or system description identified, typed on white paper, in three parts as follows:
   a. Part 1: Directory, listing names, addresses and telephone numbers of Engineer, Contractor, Subcontractors and major equipment suppliers.
   b. Part 2: Operation and maintenance instructions arranged by system and subdivided by specification section. For each category, identify names, addresses and telephone numbers of Subcontractors and suppliers. Identify the following:
      1) Significant design criteria.
      2) List of equipment.
      3) Parts list for each component.
      4) Operating instructions.
      5) Maintenance instructions for equipment and systems.
      6) Maintenance instructions for special finishes including recommended cleaning methods and materials, and special precautions identifying detrimental agents.
   c. Part 3: Project documents and certificates, including the following:
      1) Shop drawings and product data.
      2) Air and water balance reports.
      3) Certificates.
      4) Photocopies of warranties
      5) Originals of bonds.

B. Contents, Each Volume:
1. Table of Contents: Provide title of Project; names, addresses and telephone numbers of Engineer and Contractor with name of responsible parties; schedule of products and systems, indexed to content of the volume.
2. For each Product or System: List names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.
3. Product Data: Mark each sheet to clearly identify specific products and

components parts, and data applicable to installation. Delete inapplicable information.

4. Drawings: Supplement product data to illustrate relations of components parts of equipment and systems, to show control and flow diagrams.
5. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions specified in the "Quality Requirements" Section of the General Requirements.
6. Warranties: Bind in copy of each.
7. Bonds: Bind in original of each.

1.10 MANUAL FOR MATERIALS AND FINISHES

A. Submit four copies of preliminary draft or proposed formats and outlines of contents before start of Work. The Engineer will review draft and return one copy with comments.

B. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit documents within ten days after acceptance.

C. Submit one copy of completed volumes 15 days prior to final inspection. Draft copy will be reviewed and returned after final inspection, with the Engineer's comments. Revise content of document sets as required prior to final submission.

D. Submit four sets of revised final volumes in final form within 10 days after final inspection.

E. Products, Applied Materials and Finishes: Include product data, with catalog number, size, composition, and color and texture designations. Include information for reordering custom manufactured products.

F. Instructions for Care and Maintenance: Include manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

G. Moisture Protection and Weather Exposed Products: Include product data listing applicable reference standards, chemical composition and details of installation. Include recommendations for inspections, maintenance and repair.

H. Additional Requirements: As specified in individual product specification sections.

I. Include listing in Table of Contents for design data, with tabbed fly sheet and space for insertion of data.

1.11 MANUAL FOR EQUIPMENT AND SYSTEMS

A. Submit four copies of preliminary draft or proposed formats and outlines of contents before start of Work. The Engineer will review draft and return one copy with comments.

B. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit documents within ten days after acceptance.

C. Submit one copy of completed volumes 15 days prior to final inspection. Draft copy will be reviewed and returned after final inspection, with the Engineer’s comments. Revise content of document sets as required prior to final submission.

D. Submit four sets of revised final volumes in final form within 10 days after final inspection.

E. Each Item of Equipment and Each System: Include description of unit or system, and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model number of replaceable parts.

F. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications.

G. Include color coded wiring diagrams as installed.

H. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and special operating instructions.

I. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

J. Include servicing and lubrication schedule, and list of lubricants required.

K. Include manufacturer's printed operation and maintenance instructions.

L. Include sequence of operation by controls manufacturer.

M. Include original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

N. Include control diagrams by controls manufacturer as installed.

O. Include Contractor's coordination drawings, with color coded piping diagrams as installed.

P. Include charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

Q. Include list of original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

R. Include test and balancing reports as specified in the "Quality Requirements" Section of the General Requirements.

S. Additional Requirements: As specified in individual product specification sections.

T. Include listing in Table of Contents for design data, with tabbed dividers and space for insertion of data.

1.12 INSTRUCTION OF EMPLOYER PERSONNEL

A. Before final inspection, instruct Employer's designated personnel in operation, adjustment, and maintenance of products, equipment, and systems, at agreed upon times.

B. For equipment requiring seasonal operation, perform instructions for other seasons within six months.

C. Use operation and maintenance manuals as basis for instruction. Review contents of manual with personnel in detail to explain all aspects of operation and maintenance.

D. Prepare and insert additional data in Operation and Maintenance Manual when need for such data becomes apparent during instructions.

1.13 SPARE PARTS AND MAINTENANCE PRODUCTS

A. Furnish spare parts, maintenance and extra products in quantities specified in individual specification sections.

B. Deliver to Project site and place in location as directed by Owner; obtain receipt prior to final payment.

1.14 PRODUCT WARRANTIES AND PRODUCT BONDS

A. Obtain warranties and bonds executed in duplicate by responsible subcontractors, suppliers and manufacturers, within ten days after completion of applicable item of work.

B. Execute and assemble transferable warranty documents and bonds from subcontractors, suppliers, and manufacturers.

C. Verify documents are in proper form, contain full information and are notarized.

D. Co-execute submittals when required.

E. Include Table of Contents and assemble in binder with durable plastic cover.

F. Submit prior to final Application for Payment.

G. Time of Submittals:
1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within ten days after acceptance.
2. Make other submittals within ten days after Date of Substantial Completion, prior to final Application for Payment.
3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within ten days after acceptance, listing date of acceptance as beginning of warranty or bond period.

1.15 MAINTENANCE SERVICE

A. Furnish service and maintenance of components indicated in specification sections.

B. Examine system components at frequency consistent with reliable operation. Clean, adjust and lubricate as required.

C. Include systematic examination, adjustment and lubrication of components. Repair or replace parts whenever required. Use parts produced by manufacturer of original component.

D. Do not assign or transfer maintenance service to agent or Subcontractor without prior written consent of the Owner.

1.16 PROTECTION AND MAKING GOOD

A. The Contractor shall protect all completed Works from damage until the completion and handing over of the Works to the approval of the Engineer.

B. Should any Works be damaged before handing over of the Works, the Contractor shall at his expense make good or replace as required, to the satisfaction of the Engineer.

END OF SECTION

DIVISION 2 – SITE CONSTRUCTION

EARTHWORK (GENERAL)

3-1-A-1 Description

This work shall consist of clearing and grubbing, stripping, removal of unsuitable soil, excavation, fill and backfill, and other specified works related to the earthwork.

3-1-A-2 General Requirements

Prior to any excavation in the streets, a license request together with all detailed drawings showing the locations of the excavations and a written commitment to restore the street to its initial condition shall be submitted to the Engineer.

Excavation in streets and roads shall not commence without written approval from the Engineer.

Before the commencement of any earthworks or demolition the sites shall be surveyed as necessary in conjunction with the Engineer's representative to establish existing ground levels.

The Contractor shall not start any earthwork before getting the Engineer's approval on the cross sections.

The Contractor shall correct all disapproved cross sections and resubmit them for approval.

The Contractor shall excavate, refill and restore in advance of his program such trial holes as he may require for determining the nature of the subsoil and the location of existing underground services and obstructions.

The Contractor shall ensure that there are no pipes, cables, mains or other services or property which may be disturbed or damaged by its use. He will take all precautions not to damage these services and restore these services if damaged on his own expense.

3-1-A-2-1 Clearing & Grubbing

3-1-A-2-1-1 Description

This work shall consist of clearing, grubbing, removing and disposing of all vegetation and debris within the limits specified. This work shall also include the preservation from injury or defacement of all vegetation and objects designated to remain.

3-1-A-2-1-2 General Requirements

The areas to be cleared and grubbed shall be as shown on the Plans, as designated in the Specifications or as directed by the Engineer. The Engineer will designate all trees, shrubs, plants and other things to remain. The Contractor shall preserve all things designated to remain.

Before carrying out work, the Site shall be inspected by the Contractor in conjunction with the Engineer to establish its general condition which shall be agreed and recorded in writing, and where in the opinion of the Engineer it is deemed necessary, by means of photography.

Details recorded shall include the location of all boundary and survey beacons, the condition of buildings, surfaces terracing (if any), ditches, watercourses roads, tracks, fences, and other information relating to the Site and elsewhere which may be affected by the works.

In the case of wayleaves for pipelines, the boundaries of the wayleave will be defined by the Employer and the Contractor shall provide, erect, and maintain in position from commencement to final completion of the Works, in every section substantial timber stakes or similar approved markers not less than 1.5m high indicating the position of the boundary at 50m or other such intervals as the Engineer may direct. In the event of any boundary or survey mark established for the purpose of land title being disturbed or displaced, the Contractor shall forthwith replace the beacon. Where necessary the Contractor shall employ the services of an approved licensed surveyor for the purpose of setting out boundaries.

Before beginning clearance in any area the Contractor shall give seven days written notice of his intention to the Engineer who will determine the extent and limits of such clearance.

All surface objects and all trees, stumps, roots, sod and vegetable matter, other protruding obstructions, not designated to remain shall be cleared and grubbed.

Within the limits of clearing and grubbing, all stumps, roots 4 cm in diameter or larger, buried logs, and all other objectionable material shall be removed 90 cm below the existing ground surface or subgrade, whichever is deeper.

Except in areas to be excavated, stump holes and other holes from which obstructions are removed shall be backfilled with suitable material and compacted to 90% of Maximum Dry Density.

Topsoil shall mean the surface layer of soil which by its humus content supports vegetation and is unsuitable, as a formation to roads and concrete structures or as a backfill or bedding material. The extent and depth of topsoil that needs removal shall be agreed with the Engineer.

Topsoil shall be set aside for re-use or disposal off site as directed by the Engineer.

Trees to be removed shall be uprooted or cut down as near to the ground level as possible.

Bushes, undergrowth, small trees, stumps and tree roots shall, where directed by the Engineer, be grubbed out. All holes left by the stumps or roots shall to backfilled with suitable material in a manner approved by the Engineer.

Materials arising out of site clearance shall be disposed by the Contractor off the Site, or where approved by the Engineer on the Site in a manner and place approved by the Engineer.

The Engineer may require that individual trees, shrubs and hedges are preserved and the Contractor shall take all necessary precautions to prevent their damage.

In the case of wayleaves for pipelines and the like, the Contractor shall preserve as far as practicable all grass and other vegetation outside the limits of trenches and permanent works and shall not unnecessarily destroy crops or any vegetation whose removal would not be essential to his operations.

The Contractor shall take care at all times to prevent erosion on every site and elsewhere on land which may be affected by his operations and the Engineer may impose such reasonable limitations and restrictions upon the method of clearance and upon the timing and season of the year when clearance is carried out as the circumstances warrant.

3-6-A AGGREGATES

3-6-A-1 Sources of Materials

All aggregates for use in the construction of the base course shall be obtained only from sources approved by the Engineer. The quarry pits or quarry extracted gravel shall be in all cases approved by the Engineer.

The Contractor shall determine the location, suitability and quantity of material available as well as the cost and the amount of work required to obtain the material available.

The Contractor shall provide the Engineer prior to the schedule beginning operations with a complete statement of the origin and composition of all stone and/or gravel aggregates to be used in the work. All materials shall comply with the specified requirements for the various aggregates.

The locating and the manufacture of aggregates which will meet the requirements of the specifications are the sole responsibility of the Contractor.

The approval of the Engineer shall in no way relieve the Contractor of the responsibility of producing aggregates which meet the specifications.

No aggregate producing equipment shall be put into operation prior to the approval of the equipment by the Engineer. If after the equipment is put into operation it fails to perform as proposed, the Contractor shall provide additional approved equipment or replace the original equipment with more suitable equipment, as may be directed by the Engineer.

3-6-A-2 Testing

In order to ascertain the properties of all aggregate materials, the Contractor shall submit, for approval by the Engineer, test certificates from an approved testing laboratory for all materials intended for incorporation in the work prior to starting quarry or pit operations.

Representative samples for such testing shall be taken by the Contractor, at his expense, in the presence of the Engineer, and duplicate samples shall be submitted to the Engineer for future reference.

The Contractor may, if approved by the Engineer, conduct the necessary tests in the laboratory. The tests shall be conducted in the presence of the Engineer. The resume of the qualifications must be submitted to and approved by the Engineer prior to any testing operations.

This testing, whether performed at an approved testing laboratory or in the project laboratory, shall be solely the Contractor’s responsibility and will be at the Contractor’s expense.

3-6-A-3 Approval and Inspection

All sources of materials shall be approved by the Engineer prior to procuring or processing material from such sources. Test certificates obtained by the Contractor or performed by the Contractor at his expense are intended to assist the Contractor in his estimate of the location, extent, and quantities which will comply with the specifications when properly processed, and will no way obviate the need for further testing by the Engineer. Only materials from approved sources shall be processed for incorporation into the work. Approval of specific sources of materials shall not be construed as final approval and acceptance of materials from such sources.

All processed materials shall be tested and approved before being stored on the site or incorporated in the work and may be inspected and tested at any time during the progress of their preparation and use. Questionable materials shall not be unloaded and incorporated with materials previously approved and accepted. If however, the grading and quality of the material delivered

to the site do not conform to the grading and quality as previously inspected and tested, or do not comply with the specifications, the Engineer reserves the right to reject such materials at the site of the work. Only materials conforming to the requirements of the specifications shall be used in the work.

Samples must meet all test requirements. The Contractor shall permit the Engineer to inspect any and all material used or to be used at any time during or after its preparation, or while being used during the process of the work or after the work has been completed. All such materials not complying with the required specifications, whether in place or not, shall be rejected and shall be removed promptly from the work. The Contractor shall supply, or arrange with any producer or manufacturer to supply, all necessary materials, labor, tools and equipment for such inspection.

3-6-A-4 Storage

Materials shall be stored so as to insure preservation of their specified quality and fitness for the work. They shall be placed on hard, clean surfaces and, when required by the Engineer, they shall be placed under cover. Stored materials shall be located as to facilitate prompt inspection and control. Private property shall not be used for storage purposes without written consent of the owner or lessee and payment to him, if necessary.

The center of the storage area shall be elevated and sloped to the sides so as to provide proper drainage of excess moisture. The material shall be stored in such a way to prevent segregation and coning to insure proper control of gradations and moisture. Course aggregate storage piles shall be built-up in layers not exceeding one (1) meter. The height of a stockpile shall be limited to a maximum of five (5) meters.

The equipment and methods used for stockpiling aggregates and for removing aggregates from the stockpiles must be approved by the Engineer and shall be such that no detrimental degradation of the aggregate will result and no appreciable amount of foreign material will be incorporated into the aggregate.

3-6-B AGGREGATE BASE COURSE

3-6-B-1 Description

This work shall consist of furnishing and placing well graded aggregate afggregate base course in successive layers of 15 cm, including additives if required, on a prepared surface in accordance with the specifications, and in conformity with the lines, grades, thicknesses and typical cross sections given in the drawings or as required by the Engineer.

3-6-B-2 Materials

Materials shall conform to the requirements for the class of “Aggregate Base Course”, specified on the plans or directed by the Engineer. All aggregates for base course shall consist of clean, tough, durable, sharp angle fragments free of any excess of thin or elongated pieces, and reasonably free of soft, disintegrated or decomposed stone, dirt or other deleterious matter.

3-6-B-2-1 Physical Requirements

All base course aggregate shall conform to the following physical requirements:

Loss of Sodium Sulfate Soundness

Test	10 percent maximum

Loss of Magnesium Sulfate Soundness

Test	12 percent maximum
Loss by Abrasion Test	35 percent maximum
Thin and Elongated Pieces, by	
Weight (larger than 1-inch, thickness less than 1/5 length	5 percent
Friable Particles	0.25 percent maximum

3-6-B-2-2 Aggregate Base Course - Class A

Material for class A shall consist of crushed gravel or stone fragments conforming to the following requirements:

AASHTO SIEVE	PERCENT PASSING
2 inch	100
1-½ inch	90 - 100
3/4 inch	50 - 80
No. 4	25 - 45
No. 40	10 - 20
No. 200	2 - 7

- Sand equivalent: 40% minimum (Aggregates passing through AASHTO SIEVE no: 4)
- Regular graded aggregate curve
- Loss of abrasion test: 40 % maximum

3-6-B-2-3 Aggregate Base Course - Class B

(a) Materials for Class B shall be crushed rock or crushed gravel conforming to the following grading requirements:

AASHTO SIEVE	PERCENT PASSING
2-½ inch	100
2 inch	90 - 100
1-½ inch	35 - 70
1 inch	0 - 15
½ inch	0 - 5

(b) Fine materials for Class B base course shall be quarry screenings or natural material and of suitable binding quality as approved by the Engineer. The material shall be free from foreign or organic matter, dirt, shale, clay and clay lumps, or other deleterious matter and shall conform to the following requirements :

AASHTO SIEVE	PERCENT PASSING
3/8 inch	100
No. 4	85 - 100

No. 100	10 - 30
Plasticity Index (AASHTO T 90)	6 maximum
Sand Equivalent (AASHTO T 176)	30 minimum

(c) The combined material shall consist of a mixture of all aggregates uniformly graded from course to fine to conform to the following gradation requirements:

AASHTO SIEVE	**PERCENT PASSING**
2-½ inch	100
2 inch	90 - 100
1-½ inch	60 - 90
1 inch	42 - 77
3/4 inch	35 - 70
½ inch	25 - 60
No. 4	15 - 40
No. 10	10 - 26
No. 40	5 - 15
No. 200	2 - 9

3-6-B-2-4 Aggregate Base Course - Class C

Material for Class C base course shall consist of uniform mixture of crushed rock and/or gravel with sand, silt and clay, conforming to the following requirements

AASHTO SIEVE	**PERCENT PASSING**
1-1/2 inch	100
1 inch	60 -100
3/4 inch	55 - 85
No. 4	35 - 60
No. 10	25 - 50
No. 40	15 - 30
No. 200	8 - 15

The grading is based on aggregates of uniform specific gravity, and the percentage passing the various sieves are subject to correction by the Engineer, when aggregates of varying specific gravities are used.

Liquid Limit (AASHTO T 89)	25 maximum
Plasticity Index (AASHTO T 90)	4-8 maximum
Sand Equivalent (AASHTO T 176)	50 minimum

3-6-B-2-5 Aggregate Base Course Class D

- Density >2.45 kg/dm^3
- Resistance of compression = 500 kg/cm^2 on a test cube 7cm x 7cm x 7cm
- Sand equivalent: 40 min (Aggregates passing through AASHTO SIEVE No. 4)

AASHTO SIEVE	PERCENT PASSING
2 inch	100
1 inch	40 - 95
1/2 inch	40 - 75
No. 4	30 - 60
No. 10	20 - 60
No. 40	15 - 30
No. 200	5 - 20

3-6-B-2-6 Acceptance

The aggregate will be accepted immediately following mixing, based on periodic samples taken. When the aggregate is a total aggregate, it may be accepted at the crusher. Acceptance of the material by the Engineer does not constitute acceptance of the base course, only that the material is approved for use in the base course.

3-6-B-3 Construction Requirements

3-6-B-3-1 Subgrade Preparation

The subgrade shall be well compacted, smooth, hard and uniform, all irregularities having been bladed out and rolled down for construction.

At all special grade control points, the subgrade shall be leveled to such depth that the proper thickness of base course may be constructed flush with the existing surface. The transition from normal to special section shall be of sufficient length to present no abrupt or noticeable change of grade and shall be excavated in accordance with the grades and lines shown on the plans or directed by the Engineer.

3-6-B-3-2 Maintenance of Subgrade

The roadbed being prepared shall be maintained true to cross section and grade until the base course is completed.

3-6-B-3-3 Method of Construction

3-6-B-3-3-1 Combining Aggregates and Water

Aggregates for base course shall be combined into a uniform mixture and water added either in a central mixing plant or by watering in a manner approved by the Engineer, before final placement of the material. When binder is to be added, if approved by the Engineer, it may be combined with the aggregate base by thoroughly mixing separate quantities of binder and aggregate base or

it may be combined in the central mixing plant. Adding binder by spreading it will not be permitted.

The moisture added to the aggregates shall be that required, as designated by the Engineer, to obtain the specified density thereby preparing an aggregate completely ready for compaction after spreading on the subgrade. In no case will the wetting of aggregates in stockpiles or trucks be permitted.

3-6-B-3-3-2 *Spreading and Combining Aggregates*

Unless otherwise specified, aggregate for base courses shall be delivered to the roadbed as a uniform mixture and shall be placed on the site prepared subgrade, in a uniform layer. Spreading shall be done by means of approved self-propelled stone spreaders, distributing the material to the required width and loose thickness.

The material shall be so handled, as to avoid segregation. If an aggregate spreader causes segregation in the material, or leaves ridges or other objectionable marks on the surface which cannot be eliminated easily or prevented by adjustment of the spreader operation, the use of such spreader shall be discontinued and replaced. All segregated material shall be removed and replaced with well-graded material. No “skin” patching shall be permitted.

3-6-B-3-3-3 *Compaction*

Immediately after placing, the base course material shall be compacted as required by AASHTO or equivalent.

The surface of the finished base course will be tested with a three (3) meter straightedge at selected locations. The variation of the surface from the testing straightedge between any two (2) contacts with the surface shall at no point exceed ten (10) millimeters, unless otherwise specified, when placed on or parallel to the centerline or when placed perpendicular to the centerline.

3-6-B-3-3-4 *Maintenance*

Following the construction of the aggregate base course, the compacted course shall be maintained by the Contractor at his expense. The Contractor shall, broom and maintain the base, keeping it free from raveling and other defects until such time as the bituminous prime or other surface is applied.

SECTION 02770

CEMENT CONCRETE CURBS

PART 1 GENERAL

1.1 The dimensions and shapes of the different curb types shall be as per the details in BS 7263 unless otherwise shown on the drawings.

1.2 The bedding support for such units shall be as shown on the drawings.

1.3 All precast curbs shall be hydraulically pressed complying with BS 7263, Part 1.

1.4 Curbs shall be laid and bedded in accordance with BS 7263, Part 2 on the concrete pavement slab, a mortar bed, the road base, or on a concrete foundation while it is still plastic or after it has set. All precast units shall be backed with concrete as per the designated details.

1.5 The use of cast-in-situ concrete curbs will not be permitted except with the express written approval of the Engineer.

PART 2 MATERIAL

2.1 Curbs shall be prepared with a mixture containing not less than 400 kg/cum of sulfate resisting Portland cement.

2.2 Testing of concrete curb shall be carried out in accordance with the requirements of BS 7263, Part 1.

2.3 The 28 day compressive strength of the concrete shall be not less than 30 MPa determined on 150 mm cube specimens, and not less than 75% of this figure after seven days.

2.4 Curbs shall only be precast concrete produced in a fully automatic batching plant.

2.5 Before approval of elements of commercial manufacture, cores shall be taken from a random sample to ascertain that the concrete strength is not less than 25 MPa at 7 days.

2.6 Elements shall be manufactured to the designated dimensions as standard 900 mm lengths unless specified otherwise in the contract documents.

2.7 The finished product shall be of solid appearance with clean planar faces, be free of segregation, honeycombing, pits, broken corners or other defects and there shall be no evidence of external rendering.

2.8 Bull-nosed and curved faces shall be of consistent radius with a smooth change from radius to straight.

2.9 Tolerance of manufacture shall be 3mm in any one dimension and end faces shall be truly perpendicular to base.

PART 3 EZECUTION

3.1 Elements shall be set on to the designated lines and grades. Under no circumstances shall it be permitted for levels to be set by direct measurement from pavement layers.

3.2 Unless otherwise indicated, elements shall be laid either directly onto a wet-concrete base or onto a sand /cement (3:1) mortar bedding, 25 mm thick, on a previously laid concrete base or approved sub base. The dimensions of the base and concrete shall be as designated.

3.3 After the curb units have been laid, a contiguous backing of concrete shall be poured for the elements using steel forms, unless otherwise designated. Lateral resistance shall be provided to the curbs by placing dowel bars in the backing concrete.

3.4 No pavement layers shall be laid against a kerbing until such a time as the backing is completed, backfilled and approved by the Engineer.

3.5 Joints between curbs shall have a width of 4mm.

3.6 Immediate after any concrete is in place, and for seven days thereafter, the curbs, base, and backing shall be fully cured and protected from, drying out and against the harmful effects of weather, including rain and rapid temperature changes. The method of protection shall be subject to the Engineer's approval. The use of colors curing membranes will not be permitted. Concrete not properly cured and protected will be rejected and shall be removed from the site.

3.7 All curbs shall be thoroughly cleaned of all extraneous materials.

END OF SECTION

SECTION 02780

UNIT PAVERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section provides general specifications for the following paving materials for hard landscaping:-
1. Exterior sidewalk pavers set in mortar setting beds.
2. Basalt pavers set in mortar setting beds.
3. Natural stone paving, curbs, steps, etc. set in mortar setting beds.
4. Stone facing and coping to works in site construction.

B. Related Sections include the following:-
1. Division 3 Section “Cast-in-Place Architectural Concrete”.
2. Division 3 Section “Architectural Precast Concrete”.
3. Division 4 Section “Dimension Stone Cladding”.

1.3 SUBMITTALS

A. Product Data: For materials other than water and aggregates.

B. Product Data: For the following:-
1. Pavers.

C. Sieve Analyses: For aggregate setting-bed materials, according to ASTM C 136.

D. Samples for Initial Selection: For the following:-
1. Each type of unit paver indicated.
2. Joint materials involving color selection.

E. Samples for Verification:-
1. Full-size units of each type of unit paver indicated. Assemble not less than five Samples of each type of unit on suitable backing and grout joints.
2. Joint materials.

F. Compatibility and Adhesion Test Reports: From latex-additive manufacturer for mortar and grout containing latex additives.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from one source with resources to provide materials and products of consistent quality in appearance and physical properties.

B. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Store liquids in tightly closed containers protected from freezing.

1.6 PROJECT CONDITIONS

A. Weather Limitations for Mortar and Grout:-

1. Hot-Weather Requirements: Protect unit paver work when temperature and humidity conditions produce excessive evaporation of setting beds and grout. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 38 deg C and higher.

   a. When ambient temperature exceeds 38 deg C, or when wind velocity exceeds 13 km/h and ambient temperature exceeds 32 deg C, set pavers within 1 minute of spreading setting-bed mortar.

PART 2 PRODUCTS

2.1 EXTERIOR SIDEWALK PAVERS

A. Pavers: Solid paving units similar to existing BCD sidewalks in all respects.
1. Face Size and Shape: rectangular or shaped as instructed by Engineer.
2. Color: As selected by the Engineer.
3. Setting Materials: Cement and sand mortar.

2.2 BASALT PAVERS

A. Basalt Pavers: Shall be quarried from natural sources and shall have the following characteristics:-

1. Compressive length: 35800 psi according to ASTM C170.
2. Density: 190 according to ASTM C97.
3. Absorption by weight: 0.05% according to ASTM C97.
4. Abrasion resistance: 0.026” according to ASTM C241.
5. Size and Shape: rectangular or shaped as indicated or as otherwise instructed by Engineer.
6. Thickness: Minimum 30mm.
7. Color: Grey.
8. Setting Materials: Cement and sand mortar.

2.3 STONE PAVERS

A. Stone Pavers and Tiles: Comply with ASTM C 568. Limestone to have the following minimum properties:-
1. Density: 2560 kg/m³
2. Compression Strength: 55 MPa, min.
3. Porosity: little porosity
4. Water Absorption: 3% for high density type.

B. Description: Natural stone, each type shall be obtained from one strata of the quarry, free from faults and to shapes, sizes and patterns shown on the drawings.
1. Size and thickness: As indicated on drawings and Bill Items.
2. Color: As indicated or otherwise selected by Engineer from manufacturer’s full range.
3. Finish: As indicated.
4. Setting Materials: Cement and sand mortar.

2.4 AGGREGATE SETTING-BED MATERIALS

A. Graded Aggregate for Base: Sound, crushed stone or gravel complying with ASTM D 2940, base material.
B. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C 33 for fine aggregate.
C. Stone Screenings for Leveling Course: Sound stone screenings complying with ASTMD 448 for Size No. 10.
D. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing 1.18-mm sieve and no more than 10 percent passing 0.075-mm sieve.
2. Provide sand of color needed to produce required joint color.

2.5 MORTAR SETTING-BED MATERIALS

A. Portland Cement: ASTM C 150, Type I or II.
B. Hydrated Lime: ASTM C 207, Type S.
C. Sand: ASTM C 144.
D. Latex Additive: Manufacturer's standard water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement mortar bed, and not containing a retarder.
1. Manufacturer: Subject to compliance with requirements, provide latex additive by a manufacturer approved by the Architect.
E. Water: Potable.
F. Reinforcing Wire: Galvanized, welded, 1.57-mm diameter wire; 51-by-51-mm mesh; comply with ASTM A 185 and ASTM A 82 except for minimum wire size.

2.6 GROUT MATERIALS

A. Sand-Portland Cement Grout: ANSI A108.10, composed of white or gray cement and white or colored sand as required to produce required color.
   1. Latex Additive: Manufacturer's standard water emulsion, serving as replacement forpart or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed sand-portland cement grout.
      a. Manufacturer: Subject to compliance with requirements, provide grout by a manufacturer approved by the Architect.

B. Polymer-Modified Grout: ANSI A118.7, sanded grout; in color indicated.
   1. Manufacturer: Subject to compliance with requirements, provide grout by a manufacturer approved by the Architect.
   2. Product Type: Dry mix, containing ethylene vinyl acetate, in dry, redispersible form, prepackaged with other dry ingredients.
   3. Product Type: Two-component mix, containing acrylic resin in liquid-latex form and prepackaged dry-grout mix complying with ANSI A118.6 and recommended by latex-additive manufacturer.
   4. Product Type: Either dry mix, containing ethylene vinyl acetate, in dry, redispersible form, prepackaged with other dry ingredients, or two-component mix, containing acrylic resin or styrene-butadiene rubber in liquid-latex form and prepackaged dry-grout mix complying with ANSI A118.6 and recommended by latex-additive manufacturer.

C. Grout Colors: As selected by Engineer from manufacturer's full range.

D. Water: Potable.

2.7 MORTAR AND GROUT MIXES

A. General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce setting-bed and joint materials of uniform quality and with optimum performance characteristics. Discard mortars and grout if they have reached their initial set before being used.

B. Mortar-Bed Bond Coat: Mix neat cement or cement and sand with latex additive to a creamy consistency.

C. Portland Cement-Lime Setting-Bed Mortar: Type M complying with ASTM C 270, Proportion Specification.

D. Latex-Modified, Portland Cement Setting-Bed Mortar: Proportion and mix portland cement, sand, and latex additive for setting bed to comply with written instructions of latex-additive manufacturer and as necessary to produce stiff mixture with a moist surface when bed is ready to receive pavers.

E. Latex-Modified, Portland Cement Slurry Bond Coat: Proportion and mix portland cement, sand, and latex additive for slurry bond coat to comply with written instructions of latex-additive manufacturer.

F. Job-Mixed Portland Cement Grout: Proportion and mix job-mixed portland cement and sand to match setting-bed mortar, except omit hydrated lime and use enough water to produce a pourable mixture.

G. Job-Mixed, Polymer-Modified Portland Cement Grout: Add liquid-latex additive to portland cement and sand in proportion and concentration recommended by liquid-latex manufacturer. Proportion cement and sand to comply with written instructions of latex-additive manufacturer.
   1. Pigmented Grout: Select and proportion pigments with other ingredients to produce color required. Do not exceed pigment-to-cement ratio of 1:10, by weight.

I. Colored-Aggregate Grout: Produce color required by combining colored sand with portland cement of selected color.

H. Packaged, Polymer-Modified Grout Mix: Proportion and mix grout ingredients according to grout manufacturer's written instructions.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas indicated to receive paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.
   2. Where pavers are to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations. Examine areas where waterproofing system is turned up or flashed against vertical surfaces and horizontal waterproofing. Proceed with installation only after protection is in place.

3.2 PREPARATION

A. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.

B. Clean concrete substrates to remove dirt, dust, debris, and loose particles.

C. Proof-roll prepared sub-grade according to requirements in Division 2 Section "Earthwork" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient sub-grades have been corrected and are ready to receive base course for unit pavers.

3.3 INSTALLATION, GENERAL

A. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be visible in finished work.

B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, un-chipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
1. For concrete pavers, a block splitter may be used.

D. Joint Pattern: As indicated.

E. Pavers over Waterproofing: Exercise care in placing pavers and setting materials over waterproofing so protection materials are not displaced and waterproofing is not punctured or otherwise damaged. Carefully replace protection materials that become displaced and arrange for repair of damaged waterproofing before covering with paving.
1. Provide joint filler at waterproofing that is turned up on vertical surfaces.

F. Tolerances: Do not exceed 1.6-mm unit-to-unit offset from flush (lippage) nor 3 mm in 600 mm and 6 mm in 3 m from level, or indicated slope, for finished surface of paving.

G. Expansion and Control Joints: Provide for sealant-filled joints at locations and of widths indicated. Provide foam filler as backing for sealant-filled joints. Install joint filler before setting pavers. Sealant materials and installation are specified in Division 7 Section "Joint Sealants."

H. Expansion and Control Joints: Provide joint filler at locations and of widths indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers.

I. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.
1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit paver installation.
2. For metal edge restraints with top edge exposed, drive stakes at least 25 mm below top edge.
3. Install job-built concrete edge restraints to comply with requirements in Division 3 Section "Cast-in-Place Concrete."
4. Where pavers set in mortar bed are indicated as edge restraints for pavers set in aggregate setting bed, install pavers set in mortar and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.
5. Where pavers embedded in concrete are indicated as edge restraints for pavers set in aggregate setting bed, install pavers embedded in concrete and allow concrete to cure before placing aggregate setting bed and remainder of pavers. Hold top of concrete below aggregate setting bed.

J. Provide steps made of pavers as indicated. Install paver steps before installing adjacent pavers.
1. Where pavers set in mortar bed are indicated for steps constructed adjacent to pavers set in aggregate setting bed, install steps and allow mortar to cure before placing aggregate setting bed and remainder of pavers. Cut off mortar bed at a steep angle so it will not interfere with aggregate setting bed.

3.4 AGGREGATE SETTING-BED APPLICATIONS

A. Compact soil sub-grade uniformly to at least 95 percent of ASTM D 698 laboratory density.

B. Proof-roll prepared sub-grade to identify soft pockets and areas of excess yielding. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

C. Place separation geotextile over prepared sub-grade, overlapping ends and edges at least 300 mm.

D. Place aggregate base, compact by tamping with plate vibrator, and screed to depth indicated.

E. Place aggregate base, compact to 100 percent of ASTM D 1557 maximum laboratory density, and screed to depth indicated.

F. Place drainage geotextile over compacted base course, overlapping ends and edges at least 300 mm.

G. Place leveling course and screed to a thickness of 25 to 38 mm, taking care that moisture content remains constant and density is loose and constant until pavers are set and compacted.

H. Treat leveling course with herbicide to inhibit growth of grass and weeds.

I. Set pavers with a minimum joint width of 1.5 mm and a maximum of 3 mm, being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines. Fill gaps between units that exceed 10 mm with pieces cut to fit from full-size unit pavers.
   1. When installation is performed with mechanical equipment, use only unit pavers with spacer bars on sides of each unit.

J. Vibrate pavers into leveling course with a low-amplitude plate vibrator capable of a 16 to 22kN compaction force at 80 to 90 Hz. Perform at least three passes across paving with vibrator. Vibrate under the following conditions:
   1. After edge pavers are installed and there is a completed surface or before surface is exposed to rain.
   2. Before ending each day's work, fully compact installed concrete pavers to within 900 mm of the laying face. Cover pavers that have not been compacted, and leveling course on which pavers have not been placed, with non-staining plastic sheets to protect them from rain.

K. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Leave a slight surplus of sand on the surface for joint filling.

L. Do not allow traffic on installed pavers until sand has been vibrated into joints.

M. Repeat joint-filling process 30 days later.

3.5 REPAIRING, POINTING, AND CLEANING

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point up joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.

C. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.

1. Remove temporary protective coating from brick pavers as recommended by protective coating manufacturer and as acceptable to unit paver and grout manufacturer. Trap and remove coating to prevent it from clogging drains.

SECTION 02900

EXTERIOR PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes:-
   1. Agricultural soil in planters and gardens.
   2. Soft landscaping in planters and gardens which will be selected by the Engineer in due course. Provisional Sum has been allocated for the Bills of Quantities.

1.3 DEFINITIONS

A. Balled and Burlapped Stock: Exterior plants dug with firm, natural balls of earth in which they are grown, with ball size not less than sizes indicated or diameter and depth recommended by ANSI Z60.1 for type and size of tree or shrub required; wrapped, tied, rigidly supported, and drum-laced as recommended by ANSI Z60.1.

B. Balled and Potted Stock: Exterior plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than [sizes indicated or diameter and depth recommended by ANSI Z60.1 for type and size of exterior plant required.

C. Bare-Root Stock: Exterior plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for kind and size of exterior plant required.

D. Container-Grown Stock: Healthy, vigorous, well-rooted exterior plants grown in a container with well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for kind, type, and size of exterior plant required.

E. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted exterior plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of exterior plant.

F. Finish Grade: Elevation of finished surface of planting soil.

G. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

H. Planting Soil: Native or imported topsoil, manufactured topsoil, or surface soil modified to become topsoil; mixed with soil amendments.

I. Sub-grade: Surface or elevation of subsoil remaining after completing excavation, or top surface of a fill or backfill, before placing planting soil.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated.

B. Samples for Verification: For each of the following:-
   1. 2.2 kg of mineral mulch for each color and texture of stone required, in labeled plastic bags.
   2. Edging materials and accessories, of manufacturer's standard size, to verify color selected.

C. Product Certificates: For each type of manufactured product, signed by product manufacturer, and complying with Manufacturer's certified analysis for standard products.

D. Qualification Data: For landscape Installer.

E. Planting Schedule: Indicating anticipated planting dates for exterior plants.

F. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of exterior plants during a calendar year. Submit before expiration of required maintenance periods.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of exterior plants.
   1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when exterior planting is in progress.

B. Provide quality, size, genus, species, and variety of exterior plants indicated, complying with applicable requirements in ANSI Z60.1, "American Standard for Nursery Stock."

C. Observation: Engineer may observe plants either at place of growth or at site before planting for compliance with requirements for genus, species, variety, size, and quality. Engineer retains right to observe trees and shrubs further for size and condition of balls and root systems, insects, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.
   1. Notify Engineer of sources of planting materials seven days in advance of delivery to site.

D. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Management and Administrative Procedures."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver exterior plants freshly dug. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting.

B. Do not prune trees and shrubs before delivery, except as approved by Engineer. Protect bark, branches, and root systems from sun scald, drying, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of exterior plants during delivery. Do not drop exterior plants during delivery.

C. Handle planting stock by root ball.

D. Deliver exterior plants after preparations for planting have been completed and install immediately. If planting is delayed more than six hours after delivery, set exterior plants trees in shade, protect from weather and mechanical damage, and keep roots moist.
   1. Heel-in bare-root stock. Soak roots in water for two hours if dried out.
   2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
   3. Do not remove container-grown stock from containers before time of planting.
   4. Water root systems of exterior plants stored on-site with a fine-mist spray. Water as often as necessary to maintain root systems in a moist condition.

1.7 COORDINATION

A. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit.

B. Coordination with Lawns: Plant trees and shrubs after finish grades are established and before planting lawns, unless otherwise acceptable to Engineer. When planting trees and shrubs after lawns, protect lawn areas and promptly repair damage caused by planting operations.

1.8 WARRANTY

A. Special Warranty: Warrant the following exterior plants, for the warranty period indicated, against defects including death and unsatisfactory growth, except for defects resulting from lack of adequate maintenance, neglect, or abuse by Owner, or incidents that are beyond Contractor's control.
   1. Remove dead exterior plants immediately. Replace immediately unless required to plant in the succeeding planting season.
   2. Replace exterior plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.

3. A limit of one replacement of each exterior plant will be required, except for losses or replacements due to failure to comply with requirements.

1.9 MAINTENANCE

A. Trees and Shrubs: Maintain for the following maintenance period by pruning, cultivating, watering, weeding, fertilizing, restoring planting saucers, tightening and repairing stakes and guy supports, and resetting to proper grades or vertical position, as required to establish healthy, viable plantings. Spray as required to keep trees and shrubs free of insects and disease. Restore or replace damaged tree wrappings.
   1. Maintenance Period: 12 months from date of Substantial Completion.

B. Ground Cover and Plants: Maintain for the following maintenance period by watering, weeding, fertilizing, and other operations as required to establish healthy, viable plantings:
   1. Maintenance Period: 12 months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 TREE AND SHRUB MATERIAL

A. General: Furnish nursery-grown trees and shrubs complying with ANSI Z60.1, with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock free of disease, insects, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

B. Grade: Provide trees and shrubs of sizes and grades complying with ANSI Z60.1 for type of trees and shrubs required. Trees and shrubs of a larger size may be used if acceptable to Engineer, with a proportionate increase in size of roots or balls.

C. Label each tree and shrub with securely attached, waterproof tag bearing legible designation of botanical and common name.

D. Label at least one tree and one shrub of each variety and caliper with a securely attached, waterproof tag bearing legible designation of botanical and common name.

E. If formal arrangements or consecutive order of trees or shrubs is shown, select stock for uniform height and spread, and number label to assure symmetry in planting.

2.2 DECIDUOUS SHRUBS

A. Form and Size: Deciduous shrubs with not less than the minimum number of canes required by and measured according to ANSI Z60.1 for type, shape, and height of shrub.

2.3 GROUND COVER PLANTS

A. Ground Cover: Provide ground cover of species indicated, established and well rooted in pots or similar containers, and complying with ANSI Z60.1 and the following requirements:

2.4 PLANTS

A. Annuals: Provide healthy, disease-free plants of species and variety shown or listed. Provide only plants that are acclimated to outdoor conditions before delivery and that are in bud but not yet in bloom.

B. Perennials: Provide healthy, field-grown plants from a commercial nursery, of species and variety shown or listed.

C. Fast-Growing Vines: Provide vines of species indicated complying with requirements in ANSI Z60.1 as follows:

2.5 TOPSOIL

A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, a minimum of 4 percent organic material content; free of stones 25 mm or larger in any dimension and other extraneous materials harmful to plant growth.
   1. Topsoil Source: Import topsoil or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 100 mm deep; do not obtain from bogs or marshes.
   2. Topsoil Source: Amend existing in-place surface soil to produce topsoil. Verify suitability of surface soil to produce topsoil. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

2.6 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent and as follows:
   1. Class: Class T, with a minimum 99 percent passing through 2.36-mm sieve and a minimum 75 percent passing through 0.25-mm sieve.

      or
   2. Class: Class O, with a minimum 95 percent passing through 2.36-mm sieve and a minimum 55 percent passing through 0.25-mm sieve.

B. Sand: Clean, washed, natural or manufactured, free of toxic materials.

2.7 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 19-mm sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

B. Peat: Sphagnum peat moss, partially decomposed, finely divided or granular texture, with a pH range of 3.4 to 4.8.

C. Manure: Well-rotted, un-leached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

2.8 FERTILIZER

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 20 percent phosphoric acid.

B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
   1. Composition: 0.45 kg/92.9 sq. m of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
   2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.9 MULCHES

A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:

2.10 WEED-CONTROL BARRIERS

A. Polyethylene Sheeting: ASTM D 4397, black, 0.15-mm minimum thickness.

B. Nonwoven Fabric: Polypropylene or polyester fabric, 101 g/sq. m minimum.

C. Composite Fabric: Woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, 162 g/sq. m.

2.11 STAKES AND GUYS

A. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, redwood, or pressure-preservative-treated softwood, free of knots, holes, cross grain, and other defects, 50 by 50 mm by length indicated, pointed at one end.

B. Guy and Tie Wire: ASTM A 641/A 641M, Class 1, galvanized-steel wire, 2-strand, twisted, 2.7 mm in diameter.

C. Guy Cable: 5-strand, 4.8-mm diameter, galvanized-steel cable, with zinc-coated turnbuckles, a minimum of 75 mm long, with two 10-mm galvanized eyebolts.

D. Hose Chafing Guard: Reinforced rubber or plastic hose at least 13 mm in diameter, black, cut to lengths required to protect tree trunks from damage.

E. Flags: Standard surveyor's plastic flagging tape, white, 150 mm long.

2.12 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:

C. Grass Seed Mix: Proprietary seed mix as follows:

2.13 MISCELLANEOUS PRODUCTS

A. Tree Grates and Frames: ASTM A 48M, Class 250 or better, gray-iron castings of shape, pattern, and size indicated.

2.14 PLANTING SOIL MIX

A. Planting Soil Mix: Mix topsoil with soil amendments and fertilizers as required

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive exterior plants for compliance with requirements and conditions affecting installation and performance. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, and lawns and existing exterior plants from damage caused by planting operations.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out exterior plants at locations directed by Engineer. Stake locations of individual trees and shrubs and outline areas for multiple plantings.

D. Apply anti-desiccant to trees and shrubs using power spray to provide an adequate film over trunks, branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
   1. If deciduous trees or shrubs are moved in full leaf, spray with anti-desiccant at nursery before moving and again two weeks after planting.

3.3 TURF AREA PREPARATION

A. Limit turf sub-grade preparation to areas to be planted.

B. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 13 mm of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 SEEDING

A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 8 km/h. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
   1. Do not use wet seed or seed that is moldy or otherwise damaged.
   2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.

B. Sow seed at a total rate of (0.9 kg/92.9 sq. m).

C. Rake seed lightly into top 3 mm of soil, roll lightly, and water with fine spray.

D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets installed and stapled according to manufacturer's written instructions.

E. Protect seeded areas with erosion-control mats where shown on Drawings; install and anchor according to manufacturer's written instructions.

F. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of (42 kg/92.9 sq. m) to form a continuous blanket 38 mm in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.
   1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.
   2. Bond straw mulch by spraying with asphalt emulsion at a rate of 38 to 49 L/92.9 sq. m). Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

G. Protect seeded areas from hot, dry weather or drying winds by applying planting soil within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 4.8 mm, and roll surface smooth.

3.5 TURF MAINTENANCE

A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, re-grade, and replant bare or eroded areas and re-mulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
   1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
   2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
   3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.

B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches (10 cm).
   1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
   2. Water turf with fine spray at a minimum rate of 1 inch (25 mm) per week unless rainfall precipitation is adequate.

C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings.

D. Turf Post-fertilization: Apply fertilizer after initial mowing and when grass is dry.
   1. Use fertilizer that will provide actual nitrogen of at least (0.45 kg/92.9 sq. m) to turf area.

3.6 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:
   1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 0.92 sq. m and bare spots not exceeding 125 by 125 mm.
   2. Satisfactory Sodded Turf: At end of maintenance period, a healthy, well-rooted, even-colored, viable turf has been established, free of weeds, open joints, bare areas, and surface irregularities.
   3. Satisfactory Plugged Turf: At end of maintenance period, the required number of plugs has been established as well-rooted, viable patches of grass, and areas between plugs are free of weeds and other undesirable vegetation.

4. Satisfactory Sprigged Turf: At end of maintenance period, the required number of sprigs has been established as well-rooted, viable plants, and areas between sprigs are free of weeds and other undesirable vegetation.

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

3.7 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.8 PLANTING BED ESTABLISHMENT

A. Loosen sub-grade of planting beds to a minimum depth of 150 mm. Remove stones larger than 25 mm in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

B. Finish Grading: Grade planting beds to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

C. Restore planting beds if eroded or otherwise disturbed after finish grading and before planting.

3.9 TREE AND SHRUB EXCAVATION

A. Pits and Trenches: Excavate circular pits with sides sloped inward. Trim base leaving center area raised slightly to support root ball and assist in drainage. Do not further disturb base. Scarify sides of plant pit smeared or smoothed during excavation.
   1. Excavate at least 300 mm wider than root spread and deep enough to accommodate vertical roots for bare-root stock.

B. Subsoil removed from excavations may be used as backfill.

C. Obstructions: Notify Engineer if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

3.10 TREE AND SHRUB PLANTING

A. Set balled and burlapped stock plumb and in center of pit or trench with top of root ball flush with adjacent finish grades.

1. Remove burlap and wire baskets from tops of root balls and partially from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
2. Place planting soil mix around root ball in layers, tamping to settle mix and eliminate voids and air pockets. When pit is approximately one-half backfilled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed. Water again after placing and tamping final layer of planting soil mix.

3.11 TREE AND SHRUB PRUNING

A. Prune, thin, and shape trees and shrubs as directed by Engineer.

3.12 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants as indicated.

B. Dig holes large enough to allow spreading of roots, and backfill with planting soil.

C. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

D. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

E. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.13 PLANTING BED MULCHING

A. Install weed-control barriers before mulching according to manufacturer's written instructions. Completely cover area to be mulched, overlapping edges a minimum of 150 mm.

B. Mulch backfilled surfaces of planting beds and other areas indicated.

3.14 TREE GRATE INSTALLATION

A. Tree Grates: Set grate segments flush with adjoining surfaces as shown on Drawings. Shim from supporting substrate with soil-resistant plastic. Maintain a 75-mm minimum growth radius around base of tree; break away units of casting, if necessary, according to manufacturer's written instructions.

3.15 CLEANUP AND PROTECTION

A. During exterior planting, keep adjacent paving and construction clean and work area in an orderly condition.

B. Protect exterior plants from damage due to landscape operations, operations by other contractors and trades, and others. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged exterior planting.

C. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.

D. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.

E. Remove non-degradable erosion-control measures after grass establishment period.

3.16 DISPOSAL

A. Disposal: Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.

SECTION 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 SCOPE OF WORK

Work under this section shall include the supply, installation, testing and delivery in perfect running conditions of the electrical installations for subject project.

These installations comprise, but are not limited to, the following chapters:

Main Distribution Boards (MDB)

Lighting Panels (LPs)

Motor & Power Panels (MSPs & PPs)

Complete electrical installations for all lighting, sockets, and power outlets

HVAC and mechanical power.

Lighting fixtures

Telephone system.

Data System

Fire Alarm System

Intrusion Alarm System

Closed Circuit Television System (CCTV)

Videophone System

Earthing System

Lightning protection system and surge arresters

Uninterruptable Power Supply (UPS)

The supply shall include all the equipment, accessories and other materials not enumerated in these specifications but found necessary for the completion and perfect functioning of the installations.

Work shall be executed in a first-class work-manlike manner in accordance with these specifications, the drawings and notes indicated therein, the instructions of the Engineer, the provisions of the Bill of Quantities delivered in place and tested to the full satisfaction of the Engineer.

1.02 CONCEPT OF DESIGN

The characteristics of the electric supply shall be as follows :

Low voltage network : 3 phase, 4 wire - 50Hz
380V between phases.
220V between phases
and neutral with a solidly earthed neutral.

The necessary electric power for the needs of the project shall be supplied equipped by the local power authorities.

All embedded conduits in concrete or in floor paving screed shall be PVC conduits and all surface-mounted conduits shall be heavy duty rigid PVC conduit unless otherwise mentioned.

All junction, derivation and outlet boxes shall be bakelite type or rigid PVC material.

All outlet boxes for switches and sockets shall be bakelite type or rigid PVC material.

All feeders shall be on cable trays in the false ceiling or in the shaft.

All feeder and derivation light points shall also run in floor screed or above false ceiling or in ceiling skirting.

The loading of circuits shall be as shown on drawings with no contradiction to the local practice in Lebanon and in full compliance to the LIBNOR Codes & requirements.

Separate circuits shall be provided for : a) Lighting and socket outlets. b) Air conditioning unit or exhaust fan.

The lighting design shall have a cross-section of 2,5 mm² and a circuit breaker of (1 x 10 A + N) – Minimum wire size shall be 2.5 mm².

The convenience socket outlet and exhaust fan shall have a cross section of 4mm² and a circuit breaker (1 x 16 A + N) unless otherwise mentioned on drawings.

All work pertaining to the telephone system shall be in accordance with these specifications and shall meet all applicable rules and regulations of the local authorities.

The fire alarm system shall be as approved by local civil defense & LIBNOR regulations as laid out for connection with break glasses, optical smoke and heat detectors, manual stations, indoor and outdoors alarm bells and automatically operated fire alarm panel with repeater panel. Furthermore the connection with the fire fighting system shall be provided.

In case of an alarm, the alarm bells or horns of this building shall sound. At the same time, the alarm shall be indicated optically and acoustically on the operator's panel.

After the cause of alarm has been checked, a push button shall be operated for general alarm. The call to the fire brigade must be made by automatic phone dialer.

Earthing systems shall be TNS and in accordance with the requirements of the standards and codes mentioned in these specifications. The resistance of every earthing system shall be inferior to five (5) ohms.

Lightning protection system to be in according to the drawings, requirements of the standards and codes mentioned in these specifications. The system shall include One Early Streamer Emission air terminals, 2 flat down conductors, 2 earth pits, all in full compliance with NFC-17-102.

Surge arresters to be in according to the drawings and in full compliance with the relevant IEC codes. The system shall include a type 1&2 surge arresters at both sides of Mains and generator, and one type 2 surge arrester at each panel as shown on drawings. Low current surge arresters to be installed at all low current systems.

All the equipment shall be fit for continuous work in the heaviest conditions in Beirut.

1.03 GENERAL ELECTRICAL REQUIREMENTS

ACTUAL ROUTE OF CABLES AND CONDUITS

The location or conduits, cables, switchboards, cable trunking, etc ... is shown on the drawings approximately, therefore the actual route of cables and conduits may differ from the plans according to the details or the building construction and the conditions of execution of the installation.

The Contractor shall supply and install at his expense all secondary materials and special fittings found necessary to overcome the interference and to apply the modifications on the route of cables and conduits that are found necessary during the work to the complete satisfaction or the Engineer.

DRILLING AND CUTTING

The Contractor shall have to do all drillings and cutting of walls or other parts of the building for the complete proper installation of the conduits, cables, switchboards and other parts of equipment.

Beams, girders and other principal structural members shall not be cut or drilled unless permission has been granted by the Engineer.

If such drilling and cutting is made on finished surfaces, any marring of the surface shall be made good by repair or replacement at the Contractor's expense.

1.04 LOW VOLTAGE SYSTEM

GENERAL REQUIREMENTS

A. SCOPE OF WORK

Work described here under shall apply to the supply and installation of all materials and execution of all works necessary for the extra low voltage systems in the project, namely, telephone system, data system, fire & intrusion alarm systems, paging system, and CCTV system.

The supply shall include all the equipment, accessories and other materials not enumerated in these Specifications but necessary for the completion and perfect functioning of the systems. All to be executed in accordance with these Specifications, the drawings and notes indicated therein and the instructions of the Engineer, delivered complete in place and tested to the full satisfaction of the Engineer.

The Contractor shall coordinate the works of the extra low voltage system with the other installations to avoid any interference or damage to any of the systems or installations.

B. STUDIES TO BE PREPARED BY THE CONTRACTOR

These Specifications indicate the operation requirements of all the extra low voltage systems as well as the various types of materials to be used and their characteristics.

The Contractor shall prepare, according to the systems he is offering, all the wiring diagrams, the number and sizes of wires and cables necessary for the perfect functioning of each system.

Full selectivity, discrimination and coordination study shall be provided between consecutive breakers based on their characteristic curves.

These distribution circuits shall have enough capacity to fulfill the operation requirements under the heaviest load conditions.

No claim could be formulated by the Contractor under pretext of insufficiency of certain choices of Specifications indicated herein for the complete functioning of any of the systems required.

The above mentioned layouts and wiring diagrams shall be presented to the Engineer for approval prior to the ordering of the materials.

1.05 SUMMARY

A. This section specifies administrative and procedure requirements regarding electrical work. Additional requirements are specified in various sections of Division 16 and also may be required during the execution of work due to project conditions.

B. Requirements of this section shall include, but not be limited to, the following:

1. Submittals.
2. Coordination drawings (shop drawings).
3. Record documents (as built drawings).
4. Maintenance manuals.
5. Electrical installations.
6. Cutting and patching.
7. Temporary power and lighting.

C. The requirements of this section do not supersede or take precedence over any provision of the General Conditions and Supplementary General Conditions, and should any discrepancy become apparent between these requirements and the General Conditions and Supplementary General Conditions, the Contractor shall notify the Engineer, in writing, and the Engineer shall interpret and decide such matters in accordance with the applicable provisions of the General Conditions and Supplementary General Conditions.

1.06 QUALITY ASSURANCE

A. Materials and equipment shall conform to the latest edition of reference specifications specified herein and to applicable codes and requirements of local authorities having jurisdiction.

1. Locally manufactured products of foreign approved makes and of similar quality shall be approved by the Engineer. The Engineer shall be the sole judge to determine whether the product is of the same quality or not.

2. Code Requirements:

Comply with the latest applicable standards of the following unless specified otherwise under each section:

- The equipment, materials and installation shall satisfy the following:

- The specifications and technical conditions described in the present book of specifications.

- All electrical works shall be in accordance with LIBNOR Code while shall have precedence whenever available.

- The General Specifications for Electrical Installations of the Local Authorities (based on IEC).

- The recommendations of the "International Electro-Technical Commission (I.E.C.)".

- Requirements of the client (FDC).

Tests after the completion of the installation shall satisfy the requirements of the standards mentioned above and as mentioned here after.

1.07 SUBMITTALS

A. Definitions: The required submittals of this division, in addition to the definitions of the General Conditions, and elsewhere in the contract documents, are further categorized for convenience as follows:

1. Product data shall include manufacturer's latest standard printed literature such as manufacturers installation instructions, catalog cuts, color charts, rough-in diagrams, wiring diagrams, and performance curves on materials, equipment and systems for this project. Product data shall include references to applicable specification section and item number. Product data shall be in addition to the required shop drawing submittals.

2. Shop drawings shall include specially prepared technical data with diagrams, performance curves, data sheets, schedules, templates, patterns, reports, calculations, plans, sections, details, measurements, not in standard printed form. Shop drawings shall be in addition to the required product data and shall indicate applicable specification section and item numbers.

3. Samples shall include physical examples of materials; in complete units for visual inspection. Samples shall indicate applicable specification section number and item numbers within that section.

4. Certificates shall include statements of applicability, certifying reports from governing agencies, industry standards, and testing agencies and applicable certificates specified in each section of the specification.

5. Test and Inspection reports shall include reports specified to be required in each section of the specifications.

B. Coordination and Sequencing

a. Coordinate preparation and processing of submittals with the construction schedule and progress so that the Work will not be delayed.

b. Coordinate and sequence submittals for Work and Work interfaced with other Work so that the processing of submittals will not be delayed by the lack of required coordination between submittals.

c. The obligation to coordinate the Work indicated on any submittal material with other trades and with field conditions is the responsibility of the Contractor. No claim will be allowed for Work that may have to be moved or replaced based on a claim that the work was placed in accordance with dimensions indicated on an approved submittal.

d. No claim for an extension of Contract Time will be approved because of Contractor's failure to coordinate submissions.

C. Shop Drawings

Before starting the work, the Contractor shall submit to the Engineer for his approval, the execution of shop drawings (4 copies to be submitted) for the entire installation, especially the transfer stations, the main connections and junctions, the final route of cables and conduits and the details of the switchboards, panels, exact location of all electrical outlets & device and any other part of the installation required by the Engineer. The Engineer reserves the right to alter of modify these plans if they are found to be insufficient or not complying with the established technical standards or if they do not afford the most satisfactory performance or accessibility for repairs.

Three sets of operating and maintenance instructions covering completely the operation and maintenance of electrical systems and automatic control equipment shall be furnished to the owner.

Where necessary, one set of operating and maintenance instructions for each electrical equipment shall be framed behind glass and hung where directed.

Where necessary, three sets of lubrication charts and manuals for each item of equipment shall be furnished to the owner.

At the end of the work, the Contractor shall present three sets of as-built drawings of the whole installation, with all details required by the Engineer, and with the technical data of all installed equipment.

D. Product Data

a. Submit product data as called for under "Submittals" in each individual specification section.

b. Product data shall be submitted in sextuplicate for review. The Contractor shall indicate on copies of the literature the actual materials being submitted for review when literature contains selections.

E. Samples

a. Submit two (2) samples of each material (unless a different quantity is specified) as called for under "Submittals" in each individual section of the specifications.

b. Samples shall be delivered where directed by the Engineer. Sidewalk delivery of samples will not be accepted.

1.08 COORDINATION DRAWINGS

A. Prepare coordination drawings in accordance with provisions of the Contract Documents detailing major elements, components, and system of electrical equipment and materials in relationship with other systems, installations and

building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installation are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:

1. Indicate the proposed locations of major raceway systems, equipment, and materials. Include the following:

   a. Clearances for servicing equipment, including space for equipment disassembly required for periodic maintenance.

   d. Equipment connections and support details.

   e. Sizes and location of required concrete pads and bases.

2. Indicate scheduling, sequencing, movement and positioning of large equipment into the building during construction.

3. Prepare floor plans, elevations and details to indicate penetrations in floors, walls and ceilings and their relationship to other penetrations and installations.

1.09 RECORD DOCUMENTS

A. Prepare record documents (as built drawings) in accordance with the provisions of the Contract Documents. In addition to the requirements specified in Division 1, indicate installed conditions for:

1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and fuse and circuit breaker size and arrangements.

2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.

3. Approved substitutions, Contract Modifications and actual equipment and materials installed.

1.10 INSTRUCTION MANUALS

The supplier shall prepare and produce instruction manuals in both Arabic and English languages for the use, operation and the maintenance of the supplied equipment and installations.

1.11 MATERIALS OF THE SAME KIND

All materials of the same kind of service shall be identical and made by the same manufacturer.

1.12 TEST CERTIFICATE

The supplier shall submit test certificates where required. These shall be issued by an internationally recognized inspection office certifying that all equipment materials,

construction and functions are in agreement with the requirements of these Specifications and accepted Standards.

1.13 TEST AND ADJUSTING

After the wiring systems are completed, it shall be tested for all controls and defects. Any defects appearing shall be remedied before any apparatus, is installed.

Tests, both electrical and physical, shall be made of the various materials, equipment and installation comprising the electrical system.

After the entire installation has been completed all necessary adjustments shall be made until all Performance requirements are met.

PART 2 - PRODUCTS

(NOT USED)

BASIC ELECTRICAL REQUIREMENTS (16010) (CONT'D)

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine conditions at the job site where electrical work is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

3.02 PREPARATION

A. The Engineer's drawings issued with these specifications show the approximate location of electrical apparatus; the exact locations are subject to the approval of the Engineer. The general run of feeders, branches and conduits are indicated on the drawings. It is not intended that the exact routing of circuits or locations of conduit be determined there from.

B. The contractor shall submit a prized list of manufacturer's recommended spare parts sufficient for two years of normal operation.

3.03 INSTALLATION

A. Sequence, coordinate and integrate the various elements of electrical systems, materials and equipment.

B. Coordinate electrical systems, equipment and material installation with other building components & existing work.

C. Verify dimensions by field measurements.

D. Arrange for chases, slots and openings in other building components during progress of construction, to allow for electrical installations.

E. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

F. Sequence, coordinate and integrate installations of electrical materials and equipment for efficient flow of the Work. Give particular attention to large equipment requiring positioning prior to closing in the building.

G. Where mounting heights are not detailed or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

H. Coordinate connection of electrical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies and controlling agencies. Provide required connection for each service.

I. Install systems, materials and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Engineer.

J. Install systems, materials and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.

K. Install electrical equipment to facilitate servicing, maintenance and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations.

L. Install access panels or doors where units are concealed behind finished surfaces. Access panels and doors are specified in Division 8 Section "Access Doors" and Section 16050 "Basic Electrical Materials and Methods."

M. Employer Furnished Equipment

1. Install and connect designated motor and control equipment furnished by the Employer.

2. Connect designated equipment furnished by the Employer requiring an electric power supply.

N. Operation of Defective Equipment: The Employer reserves the right to operate operable defective equipment until it can be removed from service for correction by the Contractor.

END OF SECTION

SECTION 16110

RACEWAYS

PART 1 - GENERAL

1.01 SUMMARY

A. Provide labor, materials, equipment and services, and perform operations required for installation of Raceways and related work as indicated on the drawings or specified herein.

B. Work Included: The work of this section shall include, but not be limited to, the following:

1. Electrical metallic tubing (EMT)
2. Flexible metal conduit.
3. Liquid-tight flexible metal conduit.
4. Rigid metal conduit.
5. Rigid PVC conduit.

C. Related Work Specified Elsewhere

1. Basic Electrical Requirements - Section 16010.

2. Basic Electrical Materials and Methods - Section 16050.

1.02 SUBMITTALS

A. Submit the following in accordance with the requirements specified under "Submittals" of Section 16010.

1. Product Data: Submit manufacturer's technical product data, including specifications and installations, for each type of raceway system required. Include data substantiating that materials comply with requirements.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- Arnould (France).
- Decoduct (UAE).
- Allied Tube & Conduit (USA)
- EGA Tube (UK)
- Or any approved equal

2.02 MATERIALS

A. Conduit and Tubing

1. Provide metal conduit, tubing and fittings of types, grades, sizes and weights (wall thicknesses) for each service indicated.

2. Rigid PVC: Conduit-heavy gauge normal impact unmodified rigid PVC and shall conform to UL 651 and meet NEMA TC-2 and WC-1094 Conduits shall be resistant to heat, suitable for a continuous service temperature of 70 degrees C., and shall be corrosion-proof, non combustible, gas and watertight, acid-proof. Thin wall rigid PVC conduit shall not be permitted.

3. Rigid Steel Conduit: Rigid steel, zinc-coated, threaded type conforming to FS WW-C-581, ANSI C80.1 and UL 6. Provide zinc coating fused to inside and outside walls.

4. Flexible Metal Conduit: FS WW-C-566 and UL 1. Formed from continuous length of spirally wound, interlocked zinc-coated strip steel.

5. Liquid-Tight Flexible Metal Conduit: Liquid-tight flexible metal conduit; constructed of single strip, flexible, continuous, interlocked, and double-wrapped steel; galvanized inside and outside; coat with liquid-tight jacket of flexible polyvinyl chloride (PVC) conforming to UL360.

6. Electrical Metallic Tubing (EMT): FS WW-C-563, ANSI C80.3 and UL 797.

7. EMT Fittings: FS W-F-408, compression type, plated malleable iron or steel.

8. Conduit Straps and Supports: Hot dipped galvanized cast malleable iron or structural steel with hot dipped galvanized nuts and bolts.

9. Conduit Bushings: Insulated bushings for conduits 3/4 and larger. Provide lay-in type lugs on grounding bushings.

10. Expansion Fittings: Malleable iron-hot dipped galvanized end fittings with grounding strip and flexible tube and covered with neoprene tubing for rigid steel conduit in concrete. The use of aluminum material is prohibited.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

3.02 PREPARATION

A. Examine the Contract Drawings and specifications in order to insure the completeness of the work required under this section.

B. Verify measurements and dimensions at the job site and cooperate in the coordination and scheduling of the work of this section with the work of related trades so as not to delay job progress.

C. Provide templates as required to related trade for location of items.

3.03 INSTALLATION

A. Installation of Raceways

1. Install raceways as indicated; in accordance with manufacturer's written installation instructions, and in compliance with the applicable electrical code. Install units plumb and level, and maintain manufacturer's recommended clearances.

2. Coordinate with other work including wires/cables, boxes, and panel work, as necessary to interface installation of electrical raceway and components with other work.

B. Installation of Conduits

1. Install all conduits concealed or exposed as follows:

a. Conduit sizes shall be in accordance with applicable electrical codes, minimum size 3/4" (20 mm). Mechanically fasten together metal conduits, enclosures, and raceways for conductors to form continuous electrical conductor. Connect to electrical boxes, fittings and cabinets to provide electrical continuity and firm mechanical assembly.

b. Avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat surfaces with corrosion inhibiting compound before assembling, Burndy "Penetrox" or T&B Kopr-"Shield".

c. Install miscellaneous fitting such as reducers, chase nipples, 3-piece unions, split couplings, and plugs that have been specifically designed and manufactured for their particular application. Install expansion fitting in raceways every 200 feet linear run or wherever structural expansion joints are crossed.

d. Use roughing-in dimensions of electrically operated unit furnished by supplier. Set conduit and boxes for connection to units only after receiving review of dimensions and after checking location with other trades.

e. Provide nylon pull cord in empty conduits, with ends secured to blocks to prevent accidental removal. Provide each end of the pulling cord with a linen tag identifying the termination. Test conduits required to be installed, but left empty, test with ball mandrel. Clear any conduit which rejects ball mandrel. Pay costs involved for restoration of conduit and surrounding surfaces to original condition.

2. Conduit Installation: Provide rigid PVC conduit where embedded in concrete, masonry, under floor or earth. Follow requirements in other areas as follows:

a. Use heavy duty rigid PVC conduits above false ceiling. Exposed low current cables to be 30 cm minimum from adjacent power conduits/cables.

b. Use rigid steel conduit for exposed conduit installations other than above false ceiling, unless otherwise noted.

c. Use flexible conduit in movable partitions and from outlet boxes to recessed lighting fixtures, and final 24 inches of connection to control items subject to movement or vibration, and in cells of precast concrete panels.

d. Use liquid-tight flexible metal conduit for final 24 inches of connection to motors in damp or wet location.

e. Use Liquid-tight flexible steel galvanized conduit in the following conditions:

1) Exterior location.

2) Moist or humid atmosphere where condensate can be expected to accumulate.

3) Corrosive atmosphere.

4) Subjected to water spray or dripping oil, water or grease.

e. Cut conduits straight, properly ream, and cut threads for heavy wall and intermediate steel conduit deep and clean.

f. Field-bend conduit with benders designed for purpose so as not to distort nor vary internal diameter.

g. Make changes in direction of horizontal telephone conduit runs 1 inch or larger with minimum 36 inches radius long sweep elbow or bends.

h. Not more than the equivalent of two (2) quarter bends (180 degrees total) are permitted for telephone, data and telecommunication conduit runs between terminations.

i. Size conduit to meet applicable electrical codes.

j. Fasten conduit terminations in sheet metal enclosures by 2 locknuts, and terminate with bushing. Install locknuts inside and outside enclosure.

k. Conduits are not to cross pipe shafts, or ventilating duct openings.

l. Keep conduits a minimum distance of 6 inches from parallel runs of flues, hot water pipes or other sources of heat.

m. Support riser conduit at each floor level with clamp hangers.

n. Use of running threads at conduit joints and terminations is prohibited. Where required, use 3-piece union or split coupling.

o. Complete installation of electrical raceway before starting installation of cables/wires within raceways.

p. Install conduit so as not to cut or run through structural members, cable holes or cable slots, except by special written permission of the Engineer.

q. Concealed Conduits

1) Encase conduits installed under floors on grade in minimum 2" concrete.

2) Install underground conduits minimum of 24" below finished grade.

r. Conduits in Concrete Slabs

1) Place conduits between bottom reinforcing steel and top reinforcing steel.

2) Place conduits either parallel, or at 90 degrees, to main reinforcing steel.

3) Separate conduits by not less than diameter of largest conduit to ensure proper concrete bond.

4) Conduits crossing in slab must be reviewed for proper cover by the Engineer.

5) Embedded conduit diameter is not to exceed 1/3 of slab thickness.

s. Install conduits as not to damage or run through structural members. Avoid horizontal or cross runs in building partitions or side walls.

t. Conduit Fittings

1) Construct locknuts for securing conduit to metal enclosure with sharp edge for digging into metal, and ridged outside circumference for proper fastening.

2) Install insulated type bushings for terminating conduits 3/4" and larger. Bushings are to have flared bottom and ribbed sides. Upper edge to have phenolic insulating ring molded into bushing.

3) Bushing of standard or insulated type to have screw type grounding terminal.

4) Miscellaneous fittings such as reducers, chase nipples, 3-piece unions, split coupling, and plugs to be specifically designed for their particular application.

C. Installation of Raceways and Wireways

1. Mechanically assemble metal enclosures, and raceways for conductors to form continuous electrical conductor, and connect to electrical boxes, fittings and cabinets as to provide effective electrical continuity and rigid mechanical assembly.

a. Avoid use of dissimilar metals throughout system to eliminate possibility of electrolysis. Where dissimilar metals are in contact, coat surfaces with corrosion inhibiting compound before assembling.

b. Install expansion fittings in raceways wherever structural expansion joints are crossed.

c. Make changes in direction of raceway run with proper fittings, supplied by raceway manufacturer. No field bends of raceway sections will be permitted.

d. Properly support and anchor raceways for their entire length by structural materials. Raceways are not to span any space unsupported. Do not support raceway from ductwork.

e. Use boxes as supplied by raceway manufacturer wherever junction pull or devices boxes are required. Standard electrical "handy" boxes, etc. shall not be permitted for use with surface raceway installations.

END OF SECTION

SECTION 16111

CABLE TRAYS

PART 1 - GENERAL`

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Requirements of the following Division 16 Sections apply to this section:

1. "Basic Electrical Requirements"
2. "Basic Electrical Materials and Methods"

1.2 SUMMARY

A. This section includes metallic cable trays. Types of cable trays in this section include the following:

1. Ventilated (perforated) bottom.
2. Ladder.

B. Related Sections: The following Division Section contains requirements that relate to this section.

1. Division 7 section "Fire Stopping".
2. Division 16 section "Supporting Devices".

1.3 SUBMITTALS

General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections:

1. Product Data: Manufacturer' catalogues and data for cable tray products and accessories.
2. Shop Drawings: Layout floor plans and elevations showing cable tray system. Designate components and accessories including clamps, brackets, hanger rods, splice plates connectors, expansion joint assemblies, straight lengths, and fittings. Show accurately scaled components and spatial relationships to adjacent equipment. Show tray types, dimensions, and finishes.
3. Factory Test Reports: Certified copies of factory test reports performed in conformance with Standard approved on cable trays of types and size specified for this project.
4. Field Test Reports: in compliance with "Field Quality Control" Article of this section.
5. Maintenance data for inclusion in "Operating and maintenance Manual".

PART 2 - PRODUCTS

2.1 MANUFACTURERS (Local manufacturers strictly prohibited)

A. Approved Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include but are not limited to the following:

1. Wiremold
2. Vergokan.
3. Tallmega
4. Cooper B-Line Inc
5. ABB

or approved equal

2.2 CABLE TRAYS, GENERAL REQUIREMENTS:

A. Cable tray systems shall be of indicated types, sizes, and standard classes and shall be complete with manufacturer's recommended covers, barrier strips, dropouts, fittings, conduit adaptors, hold-down devices, grommets, and blind ends as required and indicated.

B. Cable tray products shall have rounded edges and smooth surfaces.

C. Except as otherwise indicated, provide metal cable trays, with splice plates, bolts, nuts and washers for connecting units; capable of supporting concentrated loads of 90kg at any point, over and above cable load.

D. Provide cable tray covers, where indicated; construct of metal and finishes which mate and match cable trays.

E. Provide cable tray supports and connectors, including bonding jumpers, as indicated and as recommended by cable tray manufacturer.

F. Galvanizing: is to be in accordance with ASTM B633, applied after fabrication.

G. Sizes: trays and ladders are to be standard metric sizes, 300, 600 and 900 mm wide, and at least 2,44 m length of section, minimum thickness: 1.5 mm. Size of tray or ladder is to be determined by number and sizes of cables in accordance with the Regulations and/or as shown on the Drawings. Tray or ladder is to have strength and rigidity to provide support for cables contained within. Deflection between supports is not to exceed 1/350 under full loading capacity.

H. Earthing Connector: for plastic coated trays or ladders, provide earthing connector on each coupling between adjacent sections and at distances not exceeding 30m

2.3 MATERIALS AND FINISHES:

A. Cable Trays, Fittings, and Accessories: Steel, hot-dipped galvanized after fabrication.

2.4 CABLE TRAY ACCESSORIES:

A. Covers: Solid type, of same materials and finished as cable trays.

B. Barrier Strips: Same materials and finishes and finishes as cable trays.

2.5 SUPPORTS AND CONNECTOR:

A. Cable tray supports and connectors, including bonding jumpers shall be as recommended by cable tray manufacturer.

B. Bolts and screws shall be cadmium plated or electrolytically galvanized.

2.6 FASTENERS FOR SUPPORTS:

A. Fasteners to connect cable tray supports to the building structure (at distances not exceeding 75cm apart) shall be as follows:

B. Expansion Anchors: Carbon steel wedge or sleeve type.

C. Toggle Bolts: All steel springhead type.

D. Powder-Driven Threaded Studs: Heat-treated steel, designed specifically for the intended service.

2.7 FIRE STOPPING:

A. General : Materials shall be UL listed and labeled and FM approved for fire ratings consistent with penetrated barriers.

B. Sleeves: Schedule 40, welded, black steel pipe sleeves. Sizes as indicated or minimum NEC size for cable or cable group to be installed.

C. Sealing Fittings: Suitable for sealing cables in sleeves or core drilled holes.

D. Two-Part Sealant: Formed-in-place sealant as specified in paragraph "Fire-Resistant Joint Sealers" in Division 16 Section 16050, "Basic Electrical Materials and Methods".

PART 3 - EXECUTION

3.1 Installation of cable tray systems:

A. Install cable trays in accordance with equipment manufacturer's written instruction.

B. Remove burrs and sharp edges of cable trays.

C. Conform to manufacturer's recommendations for selection and installation of supports.

D. Strength of each support including fastenings to the structure shall be adequate to carry present and future load multiplied by a safety factor of at least four or the calculated load plus 90 kg (200 lbs), whichever is greater spacing of supports is not to exceed 0.75 m.

E. Installation of supports shall be in accordance with cable tray manufacturer's written instruction and recommendations.

F. Fastening Supports: Unless otherwise indicated, fasten cable tray supports securely to the building structure as specified in Division 16 Section "Supporting Devices".

G. Support at Connections to Equipment: Where cable trays connect to equipment, provide flanged fittings fastened to the tray and to the equipment. Support the tray separately. Do not carry the weight of the tray on the equipment enclosure.

H. Thermal Contraction and Expansion: Install expansion connectors in cable tray runs that exceed the following length:

1. Steel Tray: 52.5 m (175 feet).

2. Spacing and gap settings for expansion connectors shall not exceed recommendations of approved applicable standards.

I. Direction Changes: Make changes in direction of cable tray with standard cable tray fittings.

J. Locate cable tray above piping except as required for tray accessibility and as otherwise indicated.

K. Firestopping: Where cable trays penetrate fire and smoke barriers including walls, partitions, floors, and ceilings, install fire-stopping at penetrations after cables are installed.

3.1 Installation of cable tray systems (CONT'D)

L. Sleeves For Future Cables: Install capped sleeves for future cables through fire stopped cable tray penetrations of fire/smoke barriers.

M. Working Space: Install cable trays with sufficient space to permit access for installing cables.

N. Barriers: Where trays carry conductors of different systems, such as power, communications, and data processing, or different insulation levels, use separate cable trays. In case of absolute necessity, where an Engineer's approval is required install barriers to separate the systems.

3.2 GROUNDING

A. Electrically ground cable trays and ensure continuous electrical conductivity of cable tray system. Use tray as an equipment ground conductor for itself only, not for connected equipment.

3.3 WARNING SIGNS:

A. After installation of cable trays is completed, install warning signs, on or in proximity to cable trays, where easily seen by occupants of space.

3.4 FIELD TESTING:

A. Earthing: Test cable trays to ensure electrical continuity of bonding and grounding connections.

1. Furnish equipment, including jacks, jigs, fixtures, and calibrated indicating scales required for reliable testing. Obtain the Engineer's approval before transmitting loads to the structure. Test to 90 percent of rated proof-load for fastener. If fastening fails test, replace fastener and retest until satisfactory results are achieved.

3.5 CLEANING AND FINISH REPAIR:

A. Upon completion of installation of cable trays, inspect trays, fittings, and accessories. Remove burrs, dirt, and construction debris and repair damaged finish including chips, scratches, and abrasions.

B. Galvanized Finish: Repair damage with a zinc-rich paint recommended by the tray manufacturer.

C. PVC or Paint Finish: Repair damage with matching touch-up coating recommended by the tray manufacturer.

END OF SECTION

SECTION 16116

DISTRIBUTION, SUB-DISTRIBUTION AND FINAL BRANCH CIRCUIT PANELBOARDS

1. GENERAL

ELECTRICAL WORK GENERALLY is to be in accordance with the requirements of Sections 16010 of the Specification.

DESCRIPTION OF WORK: panelboards for distribution and sub-distribution of electric power and for protection of circuits, including fixing and supporting materials and materials for termination of feeders, sub-circuits and branch circuits.

STANDARDS: panelboards generally are to comply with the requirements of IEC 439, Factory-Built Assemblies of Low Voltage Switchgear and Control Gear.

DESIGNATIONS: panelboards are designated on the Drawings and in the Schedules as follows:

LP:

final branch circuit panelboards, power panelboards and sub-distribution panelboards respectively, for secondary lighting and power distribution with branch miniature circuit breaker (MCB) and main moulded case circuit breaker (MCCB) protection unless otherwise shown on the Drawings.

MSP & PP:

distribution panelboards for power distribution with MCCB protection on main incoming and outgoing feeder circuit breakers (all MCCB unless otherwise noted on drawings).

SCHEDULES indicate the designation and required type of panelboard using the following criteria:

- type of construction (MCB or MCCB), referring to type of branch circuit breakers
- voltage, number of phases and wires
- branch circuit breaker trip rating and wire size
- main circuit breaker trip rating and frame size (maximum continuous rating) for MCCB
- short-circuit interrupting capacity (IC) in kA
- special arrangement or provisions.

EQUIPMENT DATA: submit data for approval including, but not limited to, the following:

- manufacturers' catalogues indicating specific equipment selected
- types of panelboards and circuit breaker characteristics including duties and ratings compensation at and above 40 deg. C ambient conditions and corresponding temperatures within the enclosures

dimensions of panels and specific contents of each panelboard

integrated equipment tabulations for coordinated short- circuit series combinations of circuit breakers.

TESTS AND CERTIFICATES: submit complete certified manufacturer's type test and routine test records in accordance with the Standards.

SHOP AND CONSTRUCTION DRAWINGS: submit drawings for approval including, but not limited to, the following:

exact composition of each panelboard, indicating busbar rating, frame or continuous rating and trip ratings of circuit breakers

typical installation details of panelboards, indicating main feeder and branch circuit conduit connections, terminal provisions, tags, labels, mounting methods and materials used.

ELECTRICAL CLOSETS are to be checked for clearances, spaces and ventilation, for the installation of proposed equipment, prior to starting construction.

APPROVED MANUFACTURERS: obtain panelboards from one of the following:

A. Schneider	(France)
B. Moeller	(Germany)

or other equal and approved.

2.1 DISTRIBUTION, SUBDISTRIBUTION AND FINAL BRANCH PANELBOARDS

2.1.1. GENERAL REQUIREMENTS

RATED INSULATION VOLTAGE is to be in accordance with the respective Standards.

PANELBOARDS are to be totally enclosed, dead front type, protection code IP 42 for indoor installations and IP 55 for outdoor installations, in accordance with IEC 144, and are to be factory designed and assembled. Indoor panels to be steel type with glass window.

EARTHING BAR is be provided in every panelboard.

PROTECTION is to be fully rated throughout the systems.

SERIES (CASCADE) COORDINATED PROTECTION (integrated equipment short-circuit ratings) will not be acceptable.

CIRCUIT BREAKERS are to be non-fused type.

CIRCUIT BREAKER ARRANGEMENT: panelboards are to have one main incoming circuit breaker and the required number of branch circuit breakers, arranged as shown on the Schedules, including spare circuit breakers and spaces for future expansion. Three-phase panelboards are to be designed for sequence phase connection of branch circuit devices.

BRANCH CIRCUIT NUMBERING: on 3-phase panelboard schedules, circuits 1 and 2 are to be connected to red (R) phase, 3 and 4 to yellow (Y) phase, 5 and 6 to blue (B) phase etc., to conform with branch circuit numbering shown on the Drawings.

2.1.2 PANELBOARD ENCLOSURES

TYPE: general purpose type, suitable for relevant ambient conditions, flush or surface mounted as shown on the Drawings, comprising box, trim, or trim and door to approved manufacturer's standards and sizes.

CONSTRUCTION: box, trim and doors where required, are to be electro-galvanized sheet steel of gauges not less than specified and in accordance with the Standards. Welded joints are to be galvanized after manufacture. Gutter spaces are to conform to the Standards, but are not to be less than 100 mm on all sides. Enclosure is to have predesigned angles or threaded end studs to support and adjust mounting of interior panelboard assembly.

TRIMS are to cover and overlap front shield, covering all terminals and bus compartments, to form a dead front panel. Trims are to be fixed to cabinet/box by quarter-turn clamps engaging flange of box (use of screws engaging holes in flange of box is not acceptable). Screws where used are to be oval-head, countersunk and flush. Trims for flush mounted panelboards are to overlap box and front shields by at least 20 mm. Trims for surface mounted panelboards are to be exactly sized to form flush fit to box.

DOORS are to have concealed hinges integral with trim, and flush combination cylinder lock and catch. Doors over 1000 mm high are to have vault-type handle and multiple point latch mechanism. Locks are to be keyed alike.

FINISH: inner and outer surfaces of cabinet/boxes, trims, doors etc. are to be cleaned, phosphatized, chrome passivated and treated with final thermosetting epoxy powder modified by polyester resins providing high resistance to mechanical injury, heat, acid and alkali solvents, grease, ageing and corrosion and of standard grey colour to the approval of the Engineer.

DIRECTORIES under glassene, or an approved alternative durable arrangement, are to be provided on inside face of doors, or in metal label holders when trim without doors is specified. Directories are to be typed to identify panelboards and clearly indicate circuit number and description of load.

OUTDOOR ENCLOSURES are to be heavy duty sheet steel cabinets, minimum 1.5 mm thick, fully weatherproofed (IP 55), without knockouts, but with removable sealed/gasketed bottom gland plates and gasketed doors.

2.1.3. BUSBARS

TYPE: one piece, 98% pure electrolytic copper, based on maximum total temperature rise of 40 deg. C over an ambient of 50 deg. C at full continuous rating. Bolted or clamped contact surfaces are to have maximum current density not exceeding requirements of the approved standards. Aluminium is not to be used for busbars or panelboard parts.

DESIGN: busbars are comb type with protective cover for unused parts. Busing and blank plates are to allow installation of future circuit devices, where indicated on the Drawings.

RATING: busbar rating is to be at least equal to main-circuit breaker frame size. Where no main circuit breaker is required, busbars are to have main lugs or disconnect switch, with nominal rating equal to standard circuit breaker frame sizes, and as shown on the Drawings.

SHORT-CIRCUIT DUTY: busbars are to carry maximum short-circuit duty of main protective device, which is to be at least maximum short-circuit at point of application for one second, without showing any signs of degradation.

NEUTRAL BAR is to be solid and fully insulated from cabinet or box. One solderless box type set-screw connector is to be provided for neutral wire of each branch circuit and one bolted clamp-type connector or anti-turn lug with set-screw for main incoming neutral wire. Neutral is to be fully sized and rated as for phase busbars.

EARTHING BAR is to be copper, brazed to panelboard cabinet, with bolted pressure connector for main conductor and one set-screw-type tunnel terminal for each outgoing conductor, to provide secure and reliable contact with all metal parts and enclosure.

2.1.4. MOULDED CASE CIRCUIT BREAKERS (MCCBs)

TYPE: tested to approved standards, totally enclosed, moulded case, constructed from high quality, high temperature resistant, tropicalized, moulded insulating materials, for normal operation at maximum temperature within enclosures at point of application, and provided with front operated single toggle type handle mechanism for manual operation of main contacts in addition to automatic operation under overcurrent conditions. Multi-pole breakers are to have common integral trip bar for simultaneous operation of all poles. Ampere rating is to be clearly visible. All terminals are to be box lug or clamp type with set screws, suitable for copper or aluminium conductors.

CIRCUIT BREAKER TRIP UNITS: unless otherwise specified or shown on the Drawings, circuit breakers up to and including 600/630 A frame size, are to be thermal-magnetic type, having bi-metallic inverse time delay overcurrent element for small overloads and instantaneous magnetic overcurrent trip

element for operation under short-circuit conditions on each pole. Circuit breakers 250 A and larger are to have adjustable instantaneous trips. Where solid state electronic trip circuit breakers are required these are indicated in the Schedules suffixed with the letter e.

2.1.5. MINIATURE CIRCUIT BREAKERS (MCBs)

A. TYPE: thermal magnetic non-adjustable type, tested in accordance with BS 3871, Part 1.

B. MINIMUM SHORT-CIRCUIT BREAKING CAPACITIES for 6 - 100 A MCB : 10 kA at 240/415 V a.c.

C. CONSTRUCTION: MCBs are to be tropicalized for operation at ambient temperatures up to 70 deg. C within panelboard enclosure and humidities up to 95%, and are to be constructed from high quality, high temperature, moulded insulating materials. Guaranteed duties and characteristics are to be submitted for temperatures above 40 deg. C. MCBs and combinational devices are to be modular, of unified profile and mounted to a standard DIN rail.

D. OPERATION: under overload conditions, thermal tripping is to provide close protection of insulated conductors. Under short-circuit conditions, magnetic trip is to operate at 7 - 10 times normal rated current (type 3 characteristic). Magnetic operation is to be in the current limiting region and opening time is not to exceed 5 milli-seconds.

2.1.5. MINIATURE CIRCUIT BREAKERS (MCBs) (CONT'D)

F. RATINGS: preferred rated currents are to be 6, 10, 15, 20, 25, 30, 40, 50, 60, 80 and 100 A, calibrated at 40 deg.C, available as 1, 2, 3 and 4-pole circuit breakers. Derating above 40 deg. C is not to exceed 1% per deg.C, and loading is not to exceed 70% of circuit breaker rating.

G. RESIDUAL CURRENT DEVICES for earth leakage protective circuit breakers are to be add-on devices, or built-in and integral with the standard circuit breaker. Non-adjustable sensitivities of 30 mA, 100 mA and 300 mA are to be available for all ratings of 2-pole and 4-pole circuit breakers.

H. AUXILIARIES, where required or shown on the Drawings, are to include alarm switch, auxiliary switch, shunt trip, under voltage trip and similar units which are to be modular additions to the circuit breakers.

2.1.6. MOULDED CASE SWITCH (MCS)

MOULDED CASE SWITCH: non-automatic on/off switching device of equal construction to equivalent circuit breaker, having no overcurrent or fault protective elements, but marked with maximum current withstand and voltage rating.

2.2. PANELBOARD ASSEMBLIES

2.2.1. DISTRIBUTION PANELBOARDS (DP or PP)

A. To have voltage rating 600 V a.c., 240 V d.c., conforming to IEC 439 form 2b and BS 5486: Part 1, class 3 (or UL listed, and meeting U.S. Federal Specification WP-115, Type 1, Class 1), surface mounted to wall, without doors (unless otherwise shown on the Drawings), suitable for ratings of main breaker and busbars ranging from 225 A to 1200 A, 3-phase, 4-wire (or 3-wire where specifically indicated), suitably and orderly arranged for any selected combination of branch MCCBs ranging from 150 A to 1200 A frame size and short-circuit interrupting ratings as shown on the Drawings. Circuit breakers smaller than 250 A frame size, where indicated, may be grouped on an integral sub-assembly mounted to main

B. CONSTRUCTION: sheet steel, minimum 1.5 mm thick for cabinet/box and door. Fronts are to be single or twin covers to shield circuit breakers, terminals and live ends.

C. INTERIOR OF PANELBOARD is to be pan assembly consisting of galvanized sheet steel chassis minimum 1.5 mm thick, folded, flanged and reinforced, with busbars vertically arranged and mounted on moulded insulators.

D. MOULDED INSULATORS are to have minimum temperature rating of 130 deg. C and insulation grade of 3.5 kV for one minute.

E. CIRCUIT BREAKERS are to be mounted in twin arrangement (except for larger circuit breakers) and bolted rigidly to copper cross and centre bus connectors.

2.2.2. FINAL BRANCH CIRCUIT, POWER AND SUB-DISTRIBUTION

<u>PANELBOARDS - GENERALLY</u>

ARRANGEMENT: to comprise set of homogeneous branch circuit breakers with unified profile and base, and one main circuit breaker. Single and multi-pole circuit breakers or other devices are to occupy modular spaces. Accommodation of contactors and split-bus arrangement or other devices is not to change regularity of standard box width.

INDOOR ENCLOSURE: sheet steel, minimum 1.0 mm thick for box/cabinet and minimum 1.5 mm thick for front shield, trim and door. Fixings for flush trim are to be adjustable to allow for mis-alignment between box and wall surface. Wiring spaces (gutters) are to be at least 100 mm wide. Larger gutters are to be provided where tap-off insulated split connectors are required. Knockouts are to be provided in top or bottom of enclosures and are to provide a neat and uniform conduit/cable terminal arrangement.

FINAL BRANCH CIRCUIT PANELBOARDS - TYPE MCB (LP panels)

A. INTERNAL ASSEMBLY: Both European DIN rail type and American busbar type configuration are approved. Locally manufactured panelboards are strictly prohibited. Panel to comprise removable back plate or back pan of rigid construction, attached to enclosure by four captive screws through keyhole fixings, and provided with DIN rails in horizontal arrangement for SPN panels and in vertical arrangement for TPN panels. Assembly is to be complete with neutral terminal block, earthing bar and one-piece insulated bolt-on/comb-type phase busbar. Busbars are to be single-phase or 3-phase with spade connectors for fixing by tightening a single screw on circuit breaker. Insulation is to be high thermal rating, capable of carrying maximum short-circuit current for one second without overheating beyond acceptable limits required by the Standards. 25% spare space to be provided with full size busbars.

B. SPN TYPE PANELBOARDS are to be suitable for 240 V maximum service voltage, single-phase and neutral, with MCBs on branch circuits and main incoming.

C. SPN TYPE MAIN CIRCUIT BREAKER is to be double-pole MCB, with or without earth leakage device (RCD), as shown on the Schedules.

D. SINGLE-POLE AND DOUBLE-POLE MCBs for 240 V service, are to have trip ratings between 6 A and 50 A, with ICs as shown on drawings.

E. TPN TYPE PANELBOARDS are to be suitable for up to 415 V a.c. maximum service voltage, 3-phase and neutral, with MCBs on branch circuits and 3 or 4-pole MCB or MCCB main incoming, as shown in the Schedules or on the Drawings.

F. TRIPLE-POLE BRANCH CIRCUIT BREAKERS are to have trip ratings between 6 A and 100 A, with IC as shown on drawings.

G. TPN TYPE PANELBOARD MAIN CIRCUIT BREAKERS are to be MCB or MCCB, 100A continuous current rating, with trip range from 25 A to 100 A, or 225 A MCCB with trip range 70 A to 225 A, with/without RCD as shown on the Drawings.

H. SHORT-CIRCUIT RATING: TPN panelboards may only have an integrated equipment (series) short-circuit rating.

3. FIELD AND INSTALLATION WORK

3.1. INSTALLATION

FIXING GENERALLY:

Align, level and securely fasten panelboards to structure

Fix surface mounted outdoor panelboards at least 25mm from wall ensuring supporting members do not prevent flow of air

Do not use connecting conduits to support panelboards

Close unused openings in panelboard cabinets.

PANELBOARD INTERIORS: do not install in cabinets until all conduit connections to cabinet have been completed.

WIRING INSIDE PANELBOARDS: to be neatly arranged, accessible and strapped to prevent tension on circuit breaker terminals. Tap-off connections are to be split and bolted type, fully insulated.

TRIM: fix plumb and square prior to painting. Fix trim for flush mounted cabinets flush with wall surface finish.

PROTECTION: treat concealed surfaces of recessed cabinets with heavy field application of water-proof compound prior to installation.

GENERALLY: carry out sample tests, as required by the Engineer, on panelboards after installation, to verify short-circuit capability of circuit breakers and busbars. Inspect conditions within panelboards and verify insulation conditions by use of a megger.

CIRCUIT BREAKERS: tests are to include operation of every circuit breaker manually. Check automatic operation of selected circuit breakers, as required by the Engineer, by applying necessary short-circuit, overload and earth leakage current for tripping circuit breaker as applicable and compare with manufacturer's data/characteristic curves. Measure and report ambient temperature inside enclosure.

3.1.2. INSPECTION AND TESTS ON SITE

INSULATION CHECK TESTS: carry out insulation tests on all busbars, between phases and between phases and earth/cabinet, and between neutral and earth. Record all readings, using 500 V megger for equipment on 240 V systems, and 1000 V megger for equipment on systems up to 600 V, for 1-minute, with circuit breakers in open position.

ROUTINE TESTS ON SITE are to be carried out, in accordance with the Standards, on all panelboards assembled from standardized components of the manufacturer outside the works of the manufacturer.

END OF SECTION

SECTION 16120

WIRES AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Section, apply to this Section.

B. Requirements of the following Division 16 Sections apply to this section:

1. "Basic Electrical Requirements."
2. "Basic Electrical Materials and Methods"

1.2 SUMMARY:

A. This Section includes wires, cables, and connectors for power, lighting, signal, control and related systems rated 600 volts and less.

B. Extent of electrical wire and cable work is indicated by drawings and schedules.

C. Types of electrical wire, cable, and connectors specified in this section include the following:

1. Single core copper conductor/cables
2. Multicore copper conductor/cables
3. Fixtures wires.
4. Control and signal cables.

D. Applications of electrical wire, cable, and connectors required for project are as follows:

1. For power distribution circuits.
2. For lighting circuits.
3. For appliance and equipment circuits.
4. For motor-branch circuits.
5. For signal and control circuits where not specified required otherwise under other sections of the specification.

E. Related Sections: The following Sections contain requirements that relate to this section:

1. Division 16 Section “Electrical Boxes and Fittings" for connectors for terminating cables in boxes and other electrical enclosures.

1.3 SUBMITTALS:

A. Product Data: submit manufacturer's data on electrical wires, cables and connectors.

B. Field Test Reports: indicating and interpreting test results relative to compliance with performance requirements of testing standards.

1.4 QUALITY ASSURANCE:

A. Regulatory Requirements: Comply with provisions of the statutory laws having jurisdiction and local codes of practice applicable to the job site/host country.

B. Conform to applicable codes and regulations regarding toxicity of combustion products of insulating materials.

C. Manufacturers: Firms regularly engaged in manufacture of electrical wire and cable products of type and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

D. IEC Compliance: Comply with IEC requirements as applicable to construction, insulation and color coding of electrical wires and cables.

E. NFPA Compliance: Comply with applicable NFPA requirements pertaining to cables and cable installations.

1.5 DELIVERY, STORAGE AND HANDLING:

A. Deliver wire and cable properly packaged in factory-fabricated type containers, wound on factory reels.

B. Store wire and cable in clean dry space in original containers. Protect products from weather, damaging fumes, construction debris and traffic.

C. Handle wire and cable carefully to avoid abrasing, puncturing and tearing wire and cable insulation and sheathing. Ensure that dielectric resistance integrity of wires/cables is maintained.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to , the following:

Wire and Cable

Liban Cable.

2.2 WIRES AND CABLES

A. General: Unless otherwise specified or shown on the Drawings, cables and other feeders are to have copper conductors. Cable conductors are to be stranded for sections 4 mm^2 and above, based on IEC 228 Class 2. Signal and control cables are to have solid conductors unless otherwise specified. Flexible cords are to have finely stranded conductors. Conductors of single core cables 25 mm^2 and above are to be compacted. Multi-core cables 35 mm^2 and above are to be sectoral shape.

1. Conductor Sizes: are to be metric and as shown on the Drawings. Conductors with cross-sectional area smaller than specified will not be accepted.

2. Building Wiring Insulation: in the absence of a national code/regulation, insulation is to be color coded or otherwise identified as follows:

   a. Neutral is to be light blue or white or black.

   b. Protective earth is to be green or green/yellow striped.

   c. Phase colors are suggested as red, yellow, dark blue for 380/220V systems.

B. LV Wires:

1. Single Core PVC Insulated Wires: unless otherwise specified single conductor wires for wiring in conduit are to have annealed copper conductors, generally with concentric strands and insulated with flame retardant, moisture and heat resistant PVC/E to IEC 227 suitable for wet locations and for conductor temperature of 85 deg. C. Wires are to be 450/750 V grade.

C. LV Cables:

1. Multi-Core PVC Insulated Cables (0.6/1 KV): to have annealed, copper conductors, insulated with PVC/E to IEC 227, flame retardant, moisture and heat resistant, suitable for wet locations and conductor temperatures of 85 deg. C, laid up, bedded with suitable filler and sheathed with PVC.

2. Multicore XLPE insulated Feeder Cables (0.6/1 KV): Single core annealed copper conductors, XLPE insulated, for conductor temperature of 90 deg. C, laid up and bedded with suitable non-hygroscpic material compatible with the insulation and PVC over sheathed, color black. Armoured cables are to have single layer of galvanized steel wire applied helically over extruded PVC bedding (which may be an integral part of filling) and over sheathed with PVC, color black. PVC oversheaths are to be type ST2 to IEC 502.

3. Flexible Cable for Connection to appliances, window fans, pendants etc.: is to be 300/500 V grade, three or four core, with tinned finely

stranded copper wires, EPR insulated, twisted and sheathed with chlorosulphonated polyethylene (CSP compound) and with strengthening cord.

4. High Temperature Cable: solid or stranded plain annealed copper conductors to BS 6360 (in sizes up to 4 mm^2), extruded silicon rubber insulation (0.6 mm radial thickness), aluminum/PVC laminate and PVC composite sheath with tinned earth continuity conductor/drain wire. Cable is to be rated 300/500V, capable of accepting voltage surges up to 5 KV, to operate continuously at 150 deg. C. and for short durations at 200 deg. C. It is to be certified to have passed IEC 331 and IEC 332 flame resistance and fire retardant tests.

D. Control and Signal Cables

1. Multicore PVC Insulated Control Cables: 0.6/1 KV rating, solid, 2.5 mm^2 or stranded 4 mm^2 plain circular copper conductors, with heat resistive PVC/E to IEC 227, rated for 85 deg. C, of 7,12,19,24,30 or 37 cores. Cores are to be laid up together and filled with non-hygroscopic material, PVC over sheathed, to form compact and circular cable for use in switchgear, control gear and generally for control of power and lighting systems.

2. PE Insulated Control and Signal Cables: for use on data systems, are to be generally 300 V rating, polyethylene insulated, color coded, tinned copper conductors (0.6 mm diameter), twisted together into pairs. Multi-pair core assembly is to be covered with binder tape, spirally wound 0.075 mm bare copper shielding tape and provided with drain wire and overall PVC sheath.

PART 3 - EXECUTION

3.1 INSTALLATION OF WIRES AND CABLES:

A. General: Install electrical cables, wires and wiring connectors as indicated, in compliance with applicable requirements of the Regulations/codes applicable, and IEC, NFPA, and in accordance with recognized industry practices.

B. Co-ordinate: wire/cable installation work including electrical raceway and equipment installation work, as necessary to properly interface installation of wires/cables with other work.

C. Run d.c. wiring in separate conduits than a.c. wiring.

D. Use pulling compound or lubricant, where necessary; compound used must not deteriorate conductor or insulation.

E. Use pulling means including, fish tape, cable, rope and basket weave wire/cable grips which will not damage cables or raceway.

F. Install exposed cable, parallel and perpendicular to surfaces, or exposed structural members, and follow surface contours, where possible.

G. Keep conductor splices to minimum. In case of splices, these are to be inside splice boxes, pull or junction boxes.

H. Install splice and tap connectors which are compatible with conductor material.

J. Tighten electrical connectors and terminals, including screws and bolts, in accordance with manufacturer's published torque tightening values. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified in recognized standards.

K. Pull cables simultaneously where more than one cable is being installed in the same raceway.

3.2 FIELD QUALITY CONTROL:

A. Prior to energization of circuitry, check installed wires and cables with megohm meter to determine insulation resistance levels to ensure requirements are fulfilled.

B. Prior to energization, test wires and cables for electrical continuity and for short-circuits.

C. Subsequent to wire and cable hook-ups, energize circuitry and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

END OF SECTION

SECTION 16135

ELECTRICAL BOXES AND FITTINGS

PART 1 -GENERAL

1.01 SUMMARY

A. Provide labor, materials, equipment and services, and perform operations required for installation of electrical boxes and fittings and related work as indicated work as indicated on the drawings and specified herein.

B. Work Included: The work shall include, but not be limited to, the following:
1. Outlet boxes
2. Junction boxes
3. Pull boxes
4. Floor boxes
5. Poke-throughs
6. Knockout closures.

C. Related Work Specified Elsewhere
1. Basic Electrical Requirements - Section 16010
2. Basic Electrical Materials and Methods - Section 16050
3. Grounding - Section 16450

1.02 QUALITY ASSURANCE

A. Materials and equipment shall conform to the latest edition of reference specifications specified herein and to applicable codes and requirements of local authorities having jurisdiction.

1. Code Compliance: Comply with electrical codes as applicable to construction and installation of electrical wiring boxes and fittings.

2. UL Compliance: Comply with applicable requirements of UL 50, UL 514-A, and UL 886 pertaining to electrical boxes and fittings where applicable. Provide electrical boxes and fittings, which are UL-listed and labeled.

3. NEMA Compliance: Comply with applicable requirements of NEMA Stds/Pub Nos. OS1, OS2 and Pub 250 pertaining to outlet and device boxes, covers and box supports.

1.03 SUBMITTALS

A. Submit the following in accordance with the requirements specified under "Submittals" in Section 16010.

1. Product Data : Submit manufacturer's data on electrical boxes and fittings.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Outlet Boxes: Provide galvanized coated flat rolled sheet-steel outlet wiring boxes, of shapes, cubic inch capacities and sizes, including box depths as required, suitable for installation at respective locations. Construct outlet boxes with mounting holes and with cable and conduit-size knockout openings in bottom and sides. Provide boxes with threaded screw holes, with corrosion-resistant cover and grounding screws for fastening surface and device type box covers, and for equipment type grounding.

1. Concrete box shall be 4 inches octagon with a removable backplate and 3/8 inch fixture stud, if required. Depth of box shall allow for a minimum of 1 inch of concrete to be poured above the backplate.

2. Lighting fixture box shall be 4 inches octagon with 3/8 inch fixture stud. For suspended ceiling work, 4 inches octagon with removable backplate where required, and two parallel bars for securing to the cross-furring channels.

3. Outlet Box Accessories: Provide outlet box accessories as required for each installation, including box supports, mounting ears and brackets, wallboard hangers, box extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, which are compatible with outlet boxes being used to fulfill installation requirements for individual wiring situations.

4. Device Boxes: Provide galvanized coated flat rolled sheet-steel device boxes of shapes, cubic inch capacities and sizes including box depths as required, nominal 4" square minimum 2-1/8" deep as required, suitable for installation at respective locations. Construct device boxes for flush mounting with mounting holes, and with cable-size knockout openings in bottom and ends, and with threaded screw holes in end plates for fastening devices. Provide cable clamps and corrosion-resistant screws for fastening cable clamps, and for equipment type grounding. Multi-device boxes shall be of the multi-gang type, minimum 2-1/4" deep. Gangable "switch" boxes are not acceptable.

5. Device Box Accessories: Provide device box accessories as required for each installation, including mounting brackets, device box extensions, switch box supports, gang box covers, plaster ears, and plaster board expandable grip fasteners, which are compatible with device boxes being utilized to fulfill installation requirements for individual wiring situations.

B. Raintight Outlet Boxes: Provide corrosion-resistant cast-aluminum, raintight outlet wiring boxes Type FS or FD and sizes, including depth of boxes, with threaded conduit holes for fastening electrical conduit, cast aluminum face plates with spring-

hinged watertight caps suitably configured for each application, including face plate gaskets and corrosion-resistant plugs and fasteners, no overlapping edges.

C. Junction Pull and Splice Boxes: Provide galvanized code-gauge sheet steel junction and pull boxes, with screw-on covers; of types, shapes and sizes to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws and washers. Boxes installed outdoors to be fabricated of aluminum. Provide cover gaskets for boxes installed outdoors or in wet or damp locations.

1. Where size of box is not indicated, size to permit pulling, racking and splicing of the cables.

2. Braze a ground connector, suitable for copper cables to the inside of the box.

3. Junction Box - Sidewalk Type: Cast iron, hot dipped galvanized with threaded conduit entrance hubs, flanged, reinforced checkered cover, gaskets, with pry bar slots and countersunk stainless steel screws.

4) Nonmetallic Boxes: Nonmetallic boxes rigid PVC shall be used only with rigid PVC conduit. It shall be constructed so as to prevent contact between the conductors in the box and the supporting screws.

It shall be made of high impact PVC and it shall be supplied as the same make of the rigid PVC conduit.

Boxes shall conform to Federal Specifications W-J805.

D. Knockout Closures: Provide corrosion-resistant box knockout closures, offset connectors, of types and sizes to suit respective installation requirements and applications.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine conditions at the job site where work of this Section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

3.02 PREPARATION

A. Examine the Contract Drawings and specifications in order to insure the completeness of the work required under this Section.

B. Verify measurements and dimensions at the job site and cooperate in the coordination and scheduling of the work of this Section with the work of related trades, so as not to delay job progress.

C. Provide templates as required to related trade for location of items.

3.03 INSTALLATION

A. Install electrical boxes and fittings as indicated; in accordance with manufacturer's written instructions, applicable requirements of the applicable electrical code and in accordance with recognized industry practices to fulfill project requirements.

B. Obtain exact location of outlets from the drawings of interior details and finishes. Refer any condition that would place an outlet box in an unsuitable location to the Engineer.

C. Mount outlet boxes for similar equipment in the same or similar areas at uniform heights. Where mounting heights are not indicated, locate outlet as required for the equipment connected thereto or as directed by the Engineer.

D. Provide blank plates on outlet boxes in which no device is installed.

E. Provide rain tight cast boxes for surface mounted weatherproof switches and receptacles.

F. Provide pull and/or splice boxes where indicated on the drawings or required to facilitate pulling of wires and cables.

G. Support boxes located above hung ceilings independently of the ceiling. Fasten boxes to the structure by bar hangers or other supports as approved by the Engineer.

H. Coordinate installation of electrical boxes and fittings with wire/cable, wiring devices, and raceway installation work.

I. Provide weathertight outlets for interior and exterior locations exposed to weather or moisture.

J. Provide knockout closures to cap unused knockout holes where blanks have been removed.

K. Install electrical boxes in those locations which ensure ready accessibility to enclosed electrical wiring. Where mounted in removable partition panels, install outlets to permit removal of panels without removing the outlet box.

L. Avoid installing boxes back-to-back in walls. Provide not less than 6 inches separation/

M. Do not install aluminum products in concrete.

N. Position recessed outlet boxes accurately to allow for surface finish thickness.

O. Set floor boxes level and flush with finish flooring material.

P. Fasten electrical boxes firmly and rigidly to substrates, or structural surfaces to which attached, or solidly embed electrical boxes in concrete or masonry.

Q. Provide insulation at the rear of outlet boxes installed within exterior walls to prevent condensation within the boxes.

R. Mounting Heights for Devices: The mounting heights for electrical outlets measured from the finished floor to the centerline of the outlet, shall be in accordance with the following, unless otherwise shown on the interior design or electrical drawings. Long dimensions of devices shall be vertical unless otherwise specified or shown on the drawings.

1. Wall Light Switches: 110 cm.
2. Wall Receptacles 30 cm.
3. Wall Exit Fixtures: Bottom of fixture 5 cm. above door frame.
4. Wall Mounted Telephone Outlets: 30 cm.
5. Wall Telephones: 110 cm.
6. Fire Alarm Pull Station: 140 cm.
7. Fire Alarm Audio or Audio/Visual Alarms: Bottom 5cm. above door frame.

S. Provide electrical connections for installed boxes.

T. Subsequent to installation of boxes, protect boxes from construction debris and damage.

U. Grounding: Upon completion of installation work, properly ground metallic electrical boxes and demonstrate compliance with requirements.

END OF SECTION

SECTION 16195

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 SUMMARY

A. Provide labor, materials, equipment and services, and perform operations required for installation of electrical identification and related work as indicated on the drawings and specified herein.

B. Work Included: The work shall include, but not be limited to, the following:

1. Electrical power, control and communication conductors, conduits, and boxes.
2. Operational instruction and warnings.
3. Danger signs.
4. Equipment/system identification signs and painting.
5. Manhole covers.

C. Related Work Specified Elsewhere

1. Basic Electrical Requirements - Section 16010
2. Basic Electrical Materials and Methods - Section 16050.

1.02 QUALITY ASSURANCE

A. Materials and equipment shall conform to the latest edition of reference specifications specified herein and to applicable codes and requirements of local authorities having jurisdiction.

1. Code Compliance: Comply with applicable electrical code requirements to installation of identifying labels and markers for wiring, cables, distribution boards, circuits, breakers, boxes, conduits, and all electrical equipment.

1.03 SUBMITTALS

A. Submit the following in accordance with the requirements specified under "Submittals" in Section 16010.

1. Product Data: Submit manufacturer's data on electrical identification materials and products.

1.03 SUBMITTALS

2. Samples: Submit samples of each color, lettering style and other graphic representation required for each identification material or system.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Except as otherwise indicated, provide manufacturer's standard products of categories and types required for each application. Where more than single type is specified for an application, provide single selection for each application.

B. Color-Coded Conduit Markers

1. Provide manufacturer's standard pre-printed, flexible or semi-rigid, permanent, plastic-sheet conduit markers, extending 360 degrees around conduits; designed for attachment to conduit by adhesive, adhesive lap joint of marker, matching adhesive plastic tape at each end of marker, or pretensioned snap-on.

2. Colors: Unless otherwise specified or required by governing regulations, provide white markers with red letters.

C. Cable Conductor Identification Bands: Provide manufacturer's standard vinyl-cloth self-adhesive cable/conductor markers of wrap-around type, either prenumbered plastic coated type, or write-on type with clear plastic self-adhesive cover flap; numbered to show circuit identification.

D. Engraved Plastic-Laminate Signs: Provide engraving stock melamine plastic laminate, complying with FS L-P-387, in size and thicknesses indicated, engraved with engraver's standard letter style of sizes and wording indicated, black face and white core plies (letter color) except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.

1. Thickness: 1/6 inch, except as otherwise indicated.

2. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate substrate.

PART 3 - EXECUTION

A. Lettering and Graphics: Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturer or as required for proper identification and operation/maintenance of electrical systems and equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.

3.01 EXAMINATION

A. Examine conditions at the job site where work of this Section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

3.02 PREPARATION

A. Examine the Contract Drawings and specifications in order to insure the completeness of the work required under this Section.

B. Verify measurements and dimensions at the job site and cooperate in the coordination and scheduling of the work of this Section with the work of related trades, so as not to delay job progress.

3.03 APPLICATION AND INSTALLATION

A. General Installation Requirements

1. Install electrical identification products as indicated, in accordance with manufacturer's written instruction, and requirements of the applicable electrical code.

2. Coordination: Where identification is to be applied to surfaces which require finish, install identification after completion of painting.

3. Regulations: Comply with governing regulations and requests of governing authorities for identification of electrical work.

B. Conduit Identification: Where electrical conduit is installed in spaces with mechanical piping which is identified by color-coded method, apply color-coded identification on electrical conduit in manner similar to piping identification. Except as otherwise specified, use white as coded color for conduit. IN shafts al conduits to be labeled every 3m maximum.

C. Equipment/System Identification

1. Install engraved plastic-laminate signs on each major unit of electrical equipment in building; including central or master unit of each electrical system including communication/control/signal system, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, 1/2" high lettering on 1-1/2" high sign (2" high where 2 lines are required), white lettering in black field. Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work.

a. Panelboards, electrical cabinets and enclosures
b. Access panel/doors to electrical facilities.

2. Install signs at locations indicated or specified. Where not otherwise indicated at location for convenience of viewing without interference with operation and maintenance of equipment. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate substrate.
3. Plates for receptacles on emergency circuits shall be painted red.
4. Receptacles on emergency circuits shall have nameplates with white letters on red background giving the panelboard and circuit number to which it is connected..
5. Provide a nameplate with 1/4 inch white letters on black background, mounted on outside of panelboard trims with nomenclature as indicated on drawings.
6. Provide a nameplate with 1/4 inch white letters on black background, mounted on the outside of local disconnects, starters, control devices, pushbuttons, selector switches and pilot lights identifying the equipment served and/or their function.
7. Provide a red dot self-adhesive identification affixed to the visible trim of lighting fixtures connected to emergency circuits.
8. Provide a typed directory card inserted behind a clear plastic covering within a frame on the inside face of panelboard door identifying circuit utilizations and locations and wire and cable color coding for each voltage system.

END OF SECTION

SECTION 16330

GENERAL LIGHTING INSTALLATIONS

1. GENERAL

ELECTRICAL WORK GENERALLY is to be in accordance with the requirements of Section 16010 of the Specification.

DESCRIPTION OF WORK: complete indoor and outdoor lighting installations including fixtures, control gear, mounting provisions, accessories and connection to circuit wiring and to corresponding lighting control equipment. Work shall also include KNX system related to façade lighting & key pad for control.

FIXTURE DESIGN AND STANDARDS: the Specification and the Drawings are a guide to the selection of lighting characteristics and lighting fixtures, giving general features of construction, materials, method of installation and conditions of operation. Unless otherwise specified, fixtures are to be manufacturer's standard series, designed and manufactured for the purpose and application required, generally in accordance with the Schedule of Lighting Fixtures and complying with IEC 598 and CISPR 15. Only fixtures backed up with software package calculation shall be approved.

DESIGN LAYOUT: fixture layout has been determined from photometric data of specified fixtures to achieve desired level and uniformity of illumination. Reflected ceiling plans are to be checked to ensure exact positions of fixtures with respect to structural members, ducts, pipes, other installations and ceiling panels/tiles, where required. Certain fixtures are shown in provisional positions, pending preparation of final equipment layout drawings. Such fixtures are to be located in coordination with final equipment layout so that illumination is as intended by the design.

EQUIPMENT DATA: submit data for approval including, but not limited to, the following:

A. Detailed literature on each fixture, lamp and control gear including manufacturer's name, catalogue number, rating, material specification, overall dimensions, operating characteristics and principles

B. details of changes to standard fixtures for adaptation to condition of installation and to the Specification

C. photometric data for lighting calculations including polar light distribution curves, coefficient of utilization, glare classification, efficiency, depreciation factors etc.

SHOP AND CONSTRUCTION DRAWINGS: submit drawings for approval including, but not limited to, the following:

A. exact position of each fixture on reflected ceiling plans, with indication of ceiling features, structural members, ducts, pipes and other fittings, as applicable and pertinent to the installation

B. installation details including suspension and mounting provision

C. purpose made fixtures or lighting assemblies with full details

D. wiring details, circuit and panelboard references, special lighting control arrangements etc.

SAMPLES: submit fully equipped sample of each fixture type, modified if required, together with color and texture samples of each fixture. (Lighting fixtures to be coordinated with ID design & submit accordingly)

2. FIELD AND INSTALLATION WORK

INSTALLATION

GENERALLY: install fixtures level, aligned and parallel or square to building lines and at uniform heights as shown on the Drawings or as approved by the Engineer. Make final height adjustment after installation. Proper drainage shall be provided for all outdoor in ground fixtures as per manufacturer recommendations.

FIXTURE SUPPORT: provide fixture and/or fixture outlet boxes with hangers, brackets and flanged bolted fittings, as necessary, to support weight of fixture. Submit details of hangers etc. and method of fastening for approval. Rigidly secure fixtures mounted on outlet boxes to fixture studs. Install hooks or extension pieces, when required, for proper installation. Provide one point of support in addition to the outlet box fixture stud for individually mounted fixtures longer than 600 mm.

STEM HANGERS: provide two stem hangers for individually mounted pendant fixtures. Stems are to have suspension aligners and are to be of suitable length for suspending fixtures at required height.

SUSPENDED CEILINGS: if ceiling construction is unable to support weight of fixtures without strain or deformation, suspend fixtures directly from building structure.

SOLID CEILINGS: coordinate dimensions of recesses in ceilings with exact fixture dimensions and structural elements.

CONTINUOUS ROWS: arrange fixtures so that individual fixtures can be removed without dismantling remaining fixtures. Provide minimum spacing between fixtures.

COVER PLATES: install cover plates over fixture outlet box or opening in ceiling or structure when left unused.

FLUSH RECESSED FIXTURES: install to completely eliminate light leakage within fixture and between fixture and adjacent finished surface.

VENTILATION: keep ventilation channels free after fixture is installed, if required by the design of the fixture.

EARTH metal frames of fixtures as described in Section 219 of the Specification.

TIGHTNESS: ensure that enclosed fixtures are reasonably insect/dust tight when installed, and completely weather- proof for installations subject to weather conditions.

LAMPS FOR PERMANENT INSTALLATION: place new lamps in fixtures immediately prior to hand-over and when instructed by the Engineer. Lamps used for temporary service are not to be used for final lamping of fixtures.

3. INSPECTION AND TESTS ON SITE

VISUAL INSPECTION: check neatness of installation, uniformity of equipment and nameplates etc.

ILLUMINATION MEASUREMENTS: to be taken at selected locations, to determine level and uniformity.

OPERATION: check lighting installations for operation including control and regulation equipment.

ELECTRICAL DATA: measure power factor, current and voltage at start for installations with discharge lamps.

3.1 KNX (EIB) work to include all facade lighting & related control.

A. The EIB system shall be installed by competent mechanics and checked out by competent technicians regularly employed by the manufacturer of the equipment.

B. Single source responsibility of the EIB contractor shall include supervision of installation, calibration, programming and checkout of the stand–alone subsystems, as well as the complete operation of the EIB.

REFERENCED STANDARDS, CODES AND ORDINANCES

A. It is the responsibility of the EIB contractor to be familiar with all codes, rules, ordinances, and regulating of the Authority Having Jurisdiction and their interpretations, which are in effect at the site of the work.

B. The latest issue of applicable standards and recommended practices of the EIBA (European Intelligent Bus Association) in effect shall form a part of the specification to the extent each agency’s relative standards or recommended practices apply to the

Systems and its components as specified herein.

C. The EIB contractor shall be solely responsible for compliance with all health and safety regulations, performing this work in a safe and competent manner, and use industry accepted installation procedures required for the work as outlined in these documents.

D. All systems equipment, components, accessories, and installation hardware shall be new and free from defects and shall be as per the latest EIB/KNX as set by NF or VDE where applicable. All components shall be in current hand and shall be a standard product of the system or device manufacturer. Refurbished or reconditioned components are unacceptable.

Each component shall bear the make, model number, device tag number (if any), and the listing label as applicable. All Systems components of a given type shall be the product of the same manufacturer.

TOOLS AND INSTRUMENTS: provide tools and instruments required for normal routine inspection, maintenance and testing as appropriate for type of system supplied.

PART 2 – PRODUCTS

2.1 MANUFACTURERS OR APPROVED EQUAL:
1. Gira (Germany)
2. Berker (Germany)

GENERAL DESCRIPTION OF SYSTEM

A. The Low Voltage Programmable Lighting Control System shall be designed & developed in accordance with the European Installation Bus technology to cover lighting in common areas as shown on drawings

B. A two-wire bus cable shall link in parallel all sensors (push buttons, brightness sensors, motion sensors, timers, etc.) and actuators (on/off controllers, dimming controllers, …etc.) to each other. The bus cable shall be a twisted pair, screened & shielded with solid conductors and shall be capable of handling information exchange and supplying power to the bus devices. Separate power supply to any of the sensors and actuators shall not be acceptable. The bus cable shall be laid in the building in the form of a linear, star or tree structure similar to the power mains. Systems requiring fixed wiring configurations shall not be acceptable.

C. The system shall be completely de-centralized and programmable. The programming shall be implemented via a PC or notebook computer located anywhere in the system and having access level passwords. Programming via local system switches or with no password security shall not be acceptable. Any device in the system shall be accessed for programming from the PC location without having to manipulate the device locally.

D. Each device in the system shall be addressable via a software programmable physical address. Any device in the system shall communicate with any other device via software programmable group addresses (telegrams). Each individual device will

respond to only those group addresses for which they are programmed to do so. There shall be an EEPROM storing the physical address, group addresses & other software parameters for every device, thus making it intelligent. No centralized processors or centralized memory storage devices shall be permitted.

E. It shall be possible to program any of the devices on-line at the working site without affecting any of the system devices or the system operation as well as off-line prior to dispatch of the material to site.

F. The entire system shall consist of bus lines each consisting of up to 64 devices. Two consecutive lines shall be connected to each other via line couplers that act as network filters and also provide communication between devices in different lines. In the event of failure of a device in one line, only the control functions controlled by that device shall be affected and all other devices shall continue to operate as normal. Any system with routers / couplers that require separate power supply shall not be acceptable.

G. The power supply module feeding power to the network shall consist of a built in backup power to compensate short voltage interruptions of up to 200 ms. This back-up power shall enable the system to put all actuators in a fail-safe position (either on or off or as it is) in the event of power failure.

H. The diagnostic modules shall scan the system for any faults in the bus wiring and display an alarm LED in the event of faults in the wiring.

I. Each of the devices shall have a built-in push button along with a LED. The LED shall lit in the event the push button is pressed and if there is power to the device, thus depicting that the device is communicating in the system.

J. In the event of power failure or bus wiring failure each of the system devices (switching modules and dimming controllers…etc.) shall be programmed to attain a fail safe position (controlled circuits to become “On”, “Off” or “As it is, Last status”)

K. All devices in the system shall be compliant to CE and IEC standards and should be manufactured in accordance with the EMC and the low voltage guidelines. Full compliance with EIBA standards and guidelines is a must. All devices shall be EIBA certified.

END OF SECTION

SECTION 16425

MAIN DISTRIBUTION BOARDS

1.1 GENERAL

ELECTRICAL WORK GENERALLY is to be in accordance with the requirements of Section 16010 of the Specification.

DESCRIPTION OF WORK: main distribution board(s) (MDBs) for low voltage (LV) distribution, ancillary mounting frames, fittings, cable termination accessories and supports.

STANDARDS:

A. MDBs panels to be manufactured in accordance to IEC 439-1, Factory-Built, and in full compliance with form 2B otherwise as indicated on drawings. **ALL MDB, MCC & PP panels to be partially type tested.**

B. Circuit breakers are to comply with IEC 947-2 as specified.

C. Other components, where not otherwise specified, are to comply with the relevant IEC standards.

D. Board / panel builder shall submit calculation sheets for heat dissipation within enclosure verifying that adequate ventilation is provided (natural and / or forced) with no derating of components inside enclosure.

EQUIPMENT DATA: submit for approval detailed description of main distribution boards and major components supported by manufacturer's catalogues, indicating compliance with the Standards, equipment characteristics, details of construction, operating data, dimensions and weights etc. Give details of miscellaneous items including incoming and outgoing feeder terminal arrangement, connections at busbars, isolating, earthing, interlocks, control devices, indicating and metering instruments etc.

TESTS AND CERTIFICATES: submit complete manufacturer's routine test records, in accordance with the local & IEC Standards.

EMERGENCY DISTRIBUTION BOARDS (16425) (CONT'D)

SHOP AND CONSTRUCTION DRAWINGS: submit drawings for approval including, but not limited to, the following:

plans and elevations with indication of built-on equipment, exact dimensions and weights

arrangement of boards inside rooms allocated, indicating spaces and clearances

arrangement of equipment inside board

one-line diagram of power system showing current ratings of switchgear and busbars and types and locations of protective gear (relays, instruments, CTs, VTs etc.)

schematic and elementary diagrams of control circuits

foundation details, grouting holes, installation details

arrangement of incoming and outgoing feeders, terminal fittings, instruments, busbar connections etc.

Tightening torque levels of all bolts related to breakers as per breaker's supplier data Sheet. (Torque levels to be submitted for approval)

TECHNICAL LITERATURE: submit the following for approval prior to placing orders for equipment manufacturer:

schedule of circuit breakers application, indicating type, range, features and characteristics, short-circuit ratings, time-current curves etc.

method of setting of protective devices for overload, short-circuit and earth-fault currents as coordinated with upstream and downstream systems based on specific coordination curves of protective devices used and specific calculated prospective short-circuit currents at various pointstest methods on site and references.

SPARE PARTS: provide manufacturer's recommended spare parts for emergency replacement and/or one year's maintenance including, but not limited to, the following:

one set of fixed and moving contacts for every type of replaceable (consumable) contact set

one operating motor and/or coil for each type of electrically operated circuit breaker

two sets of each type of indicating lights, fuses, LEDs etc.

TOOLS AND INSTRUMENTS: provide tools and instruments required for normal routine inspection and maintenance and testing of circuit breakers and protective devices as appropriate for type of switchgear supplied.

APPROVED MANUFACTURERS: obtain main distribution board from one of the following:

For components:

Moeller	(Germany)
Schneider	(France)

For enclosures

A. Eaton	(USA)
B. Logstrup	(Denmark)
C. Cubic	(Denmark)
D. Prisma	(France)

2. PRODUCTS AND SYSTEMS

EMERGENCY DISTRIBUTION BOARDS AND ACCESSORIES

2.1. GENERAL REQUIREMENTS

2.1.1. GENERALLY: Main distribution boards are to be dead-front type, metal enclosed, multi-cubicle, floor mounted, free standing, 600 V class of service switchboards, with fixed or draw-out switchgear, manually or manually and electrically operated, as shown on the Drawings, with matching vertical sections to form a continuous integral and rigid structure. All accessories to be of the same manufacturer matching the original type tested certificate, with 25% spare space to be provided with all proper accessories (Basbars,….)

2.1.2. GENERAL CONSTRUCTION: rigidly framed and bolted, with electro-galvanized sheet steel enclosures, minimum thickness 2 mm, phosphatized, primed with rust inhibiting primer and finished with thermal polymerized polyester epoxy powder coating, grey color (RAL 7032 or ANSI 61) to approval. Panels to be to be vermin, dust and rodent proof, IP42 protection to IEC 144 for indoor installations, with adequate lifting means and base-frames and capable of being moved into position and directly bolted to floor without additional sills.

2.1.3. VENTILATION: compartments are to be ventilated, where required, by approved methods complying with the Standards.

2.1.4. FASTENINGS between structural members are to be bolted.

2.1.5. EXTENSION of structure and busbars is to be possible at either end of switchboard.

2.1.6. ARRANGEMENT is to permit incoming and outgoing busbars and cables to enter enclosure as indicated on the Drawings and connect at respective terminals without inconvenience to installation or maintenance, according to form 4 of IEC 439-1.

2.1.7. REMOVING CIRCUIT BREAKERS: suitable arrangements and equipment are to be provided for extracting, lifting and unloading switchgear from enclosures as appropriate for type of switchgear.

2.1.8. SPARE AND SPACE POSITIONS are defined as follows:

spare position : fully equipped enclosure with switchgear

space position : fully equipped enclosure ready to receive switchgear.

2.1.9. BUSBARS: to be site rated for normal current as shown on the Drawings or at least site rated to same rating of main circuit breaker frame size, and braced for a symmetrical rms short-circuit duty equal to or higher than main circuit breaker interrupting duty, for minimum of one second unless otherwise specified or shown on the Drawings. Busbars are to be Rigid copper, of sufficient size to limit temperature rise to allowable insulation or equipment temperature ratings, and to maximum 50 deg. C above average ambient temperature of 35 deg. C outside enclosure. Connections and buswork are to be bolted with copper alloy hardware and are to be accessible for inspection and maintenance.

2.1.10. CONNECTIONS from busbar to switchgear are to be rated to carry full continuous current rating of switchgear frame and are to be insulated.

2.1.11. FULL SIZE NEUTRAL is to be continuous through all sections. Neutral bus is to be insulated and separate from earth bus and connected to it with removable links.

2.1.12. EARTH BUS is to extend full length of board, firmly fixed to each section in accordance with the Regulations and Standards, complete with two main earthing lugs (one at each end), and required number of feeder protective earth connectors.

2.1.13. BOARD TYPE: board(s) are to be of the Front accessible wall aligned, with fixed main circuit breaker sections (type and rating as shown in schedules) and fixed group mounted outgoing MCCB distribution section(s) as per form 4A or as per drawings with all needed separation.

2.1.14. FIXED MAIN CIRCUIT BREAKER SECTION is to individually accommodate main circuit breaker, main cable entry with terminal fitting assembly and metering compartment. Where required an additional cable pull section is to be provided, depending on actual configuration shown on the Drawing. Where placed against a wall, accessibility is to be possible from front and sides or only from front of section.

2.1.15. FRONT ACCESSIBLE FIXED GROUP-MOUNTED FEEDER MCCB DISTRIBUTION SECTIONS are to rear align with main section(s) and be of uniform depth, with all devices removable from the front and mounted on a panelboard type base. Construction is to allow all connections and maintenance to be made without rear access. Cables are to be accommodated in extra wide vertical gutters. Sides, top and rear are to be covered with removable screw-on plates having formed edges all around. Front plates are to be sectionalized and removable, covered by trims, and secured by self-tapping screws

2.1 Power Circuit Breakers (ACBs)

Air circuit breakers to be installed as shown on drawings & in accordance to IEC 947.

2.2.1- Type:

Encased in high strength, high temperature resistant, molded plastic insulating materials, for normal operation at 70°C within enclosure, to approve standards, manually operated of normal functions, and automatically tripped under over current conditions. Trip power is to derive from main power circuit, with sufficient tripping energy to reliably trip circuit breaker.

2.2.2-Construction:

Manually or manually and electrically operated, as shown on the drawings, with two-step, spring charged, stored energy mechanism, quick-make, quick-break type, electrically and mechanically trip-free, to prevent maintaining circuit breaker closed against over current condition whether under manual or automatic operation. Electrically operated circuit breakers are to have integrally mounted, spring charging motor mechanism.

Both manually or manually and electrically operated circuit breakers are to have mechanical built-in charging lever and are to include open and close direct acting push buttons. Stored energy provision is to allow open/close/open sequence of operation without use of external energy. Safety feature is to allow discharging stored energy without closing circuit breaker. Circuit breaker is to have are quenching device on each pole and replaceable arcing contacts.

2.2.3- Rating:

3-pole, 600V class, with continuous current rating (frame size) as shown on the drawings, ranging between 400A and 4000A (400, 800,1200,1600, 2000, 2500, 3000, and 4000A), fully rated (100%) for service under worst site conditions. Breakers are to be rated for a symmetrical rms service short-circuit breaking capacity as shown on the drawings, to IEC 947-2 sequence II (rated service short-circuit breaking capacity) at specified voltage and frequency, meeting IEC 947-2, sequence I, II, III and IV tests (for circuit breakers of utilization category B), tested in an enclosure substantially the same as the enclosure in which they are to be installed.

2.2.4- Trip Unit:

Trip Unit is to be totally enclosed, solid state device, interchangeable for compatible frame sizes, luggable into front of circuit breaker, tamper-proof and with transparent, sealable cover. Trip unit is to be direct-acting, current transformer operated, with flux transfer shunt trip that requires no external power. It is to have adjustable ampere setting (0.5 – 1.0 times sensor rating) with adjustable long-time delay, short-time pick-up and short-time delay, earth-fault pick-up and time delay and over-ride instantaneous discriminator. Current setting range is to be by replaceable elements within the maximum frame size rating.

2.2 Power Circuit Breakers (ACBs) (CONT'D)

Once removed, circuit breaker is to remain in the trip-free position. Earth-fault trip is to be adjustable, range up to maximum 1200A. with adjustable time delay between 0.1 and 0.5 seconds. Short time delay is to be adjustable in steps, 2-10 times sensor rating, with settable or adjustable time band having maximum fixed delay of 0.2 seconds. Selective over-ride protection is to allow full sensitivity up to interrupting capacity of circuit breaker.

2.2.5- Position Indicators:

Position indicators are to be positive with trip indication target. Target indicator is to be mechanical and is to give indication even when control power has been lost.

2.2.6- Circuit Breaker Accessories:

Circuit Breaker Accessories are to include the following:

- Pad-locking or key-locking provisions for all positions (disconnected, test, connected, closing blocking, open).
- Overload, short-circuit, and ground fault trip LEDS.
- Trip indicator and reset button.
- On/off pilot lights
- Shunt-trip coil and closing solenoid for remote control.

2.2.7- Auxiliary Contacts:

Auxiliary Contacts are to include N.O. and N.C. contacts on switchgear as required, plus 2 N.O. and 2 N.C. spare contacts.

2.2 MOULDED CASE CIRCUIT BREAKERS (MCCBs)

2.2.1 MCCBs GENERALLY are to be thermal-magnetic type for ratings below 600 A frame size, unless otherwise shown on the Drawings. MCCBs 400 A and larger are to be electronic solid-state trip type. All circuit breakers are to be 3-pole unless otherwise shown on drawings.

2.2.2 CONSTRUCTION: totally enclosed, moulded case, constructed from high quality, high temperature resistant, tropicalized, moulded insulating materials, for normal operation at 70 deg. C within enclosures, to approved standards, provided with quick-make, quick-break, trip-free switching mechanism manually operated by front toggle type handle and automatically tripped under overcurrent conditions. Multi-pole breakers are to have common integral trip

bar for simultaneous operation of all poles. Contacts are to be non-welding silver alloy with arc quenching metallic devices of approved construction. Cable terminals are to be solderless anti-turn box lug or clamp type with set screws suitable for copper or aluminium cables.

2.2.3 THERMAL OVERCURRENT TRIPS are to be compensated to allow for ambient temperature higher at breaker than at protected circuit or device. Compensation is to be applicable between 25 and 50 deg. C. In case of adjustable thermal settings, range of adjustment is not to exceed maximum trip rating shown on the Drawings.

2.2.4 ELECTRONIC TRIP CIRCUIT BREAKERS are to have solid state trip units with long time delay setting range at least between 0.5 and 1.0 times maximum trip rating, short time delay range 3 to 10 times maximum trip rating with maximum clearing time of 0.2 seconds, and instantaneous protection adjustable from 5 to 10 times continuous rating. Solid state trip units are to be insensitive to changes in ambient temperature between -20 and +55 deg. C. Earth fault protection is to be built into trip unit where specified, and is to be adjustable between 0.2 and 0.6 normal phase current pick-up with maximum time delay of 0.2 seconds, and is to be suitable for connection to external current sensor. Push-to-trip button is to be provided on cover for testing the trip unit.

2.2.5 TRIPPED POSITION: when tripped automatically by overcurrent condition, operating mechanism of circuit breaker is to assume an intermediate position clearly indicated by the handle between on and off positions.

2.2.6 INTERCHANGEABLE TRIPS: circuit breakers larger than 250 A are to have interchangeable thermal and magnetic top units and breakers with frame 400A and larger to have electronic trip units.

2.2.7 SEALING: non-interchangeable trip circuit breakers are to have sealed covers. Circuit breakers with interchangeable trips are to have trip unit covers sealed to prevent tampering.

2.2.8 CIRCUIT BREAKER RATINGS are to be non-current limiting, fully rated (100%) with continuous duty at site conditions, and with frame size and interrupting capacity to IEC 947-2, sequence II (rated service short-circuit breaking capacity), and maximum trip rating as shown on the Drawings. Interrupting capacities at specified voltage and frequency are to meet IEC 947-2 test sequence I, II, III and IV for circuit breakers of utilization category B (with intended short time withstand capability).

2.2.9 ACCESSORIES: circuit breaker design is to allow addition of electrical operator, control and interlocking functions, under-voltage release, shunt-trip coils, alarm and auxiliary switches, padlocking devices, key-lock devices, and the like. Such accessories are to be provided where shown on the Drawings.

2.1. METERING INSTRUMENTS

Digital Power-Metering: Microprocessor-Board with suitable for 3 or 4 wire system and with the following features:

1- Switch selectable digital display of the following valves with maximum tolerances as indicated:
   a. Phase currents, Each phase ±1%.
   b. Phase to phase voltages, 3 phases ±1%.
   c. Phase to Neutral voltage, 3 phases, ± 1%.
   d. Megawatts: ± 2%.
   e. Megavars: ± 2%.
   f. Power factor : + 2%.
   g. Frequency 2%.

2- Flush or Semi-flush for all metering devices.

For each EDSB, PP, DP provide one digital power meter for all electrical measures.

2.1.1. CURRENT TRANSFORMER (CT): indoor dry type, rated secondary current 5 A. Rated primary current, core size and accuracy are to be determined in accordance with nominal current of plant protected, short-circuit level and burden.

2.2. WIRING

2.2.1. ARRANGEMENT: wiring is to be modularly and neatly arranged on master terminal boards with suitable numbering strips and appropriate cartridge type fuses where required.

2.2.2. CONNECTIONS are to be made at front of terminal board and with no live metal exposed.

2.2.3. METAL CASES of instruments, control switches, relays etc. are to be connected, by bare copper conductors not less than 2.5 mm² section, to nearest earthing bar.

2.2.4. CONTROL WIRING: copper, PVC insulated, 85 deg. C, 600 V grade, and PVC sheathed for multi-core cables. Finely stranded copper conductor, silicon rubber insulated cables are to be used in proximity to higher temperature components and as flexible cable.

2.2.5. FERRULES: wires are to be fitted with numbered ferrules of approved type at each termination.

3. FIELD AND INSTALLATION WORK

3.1. INSTALLATION

3.1.1. EQUIPMENT BASES: ensure that concrete bases and foundations provided for installation of equipment are constructed in accordance with approved shop and construction drawings and equipment manufacturers' drawings and

that holes for fixing bolts and provisions for passage of cables etc. are provided as required.

3.1.2. CABLE TRENCHES: ensure that trench construction and covers provided for installation of power and control cables are in accordance with approved shop and construction drawings.

3.1.3. BUILT-IN ITEMS: ensure that equipment supports, fixings and the like, and sleeves for passage of feeders and cables which are to be built into concrete foundations, bases, cable trenches or building structure are provided as and when required and that they are properly installed.

3.1.4. EQUIPMENT: install on concrete bases etc., and assemble completely plumb and level, before grouting in holding-down bolts.

3.1.5. SUPPORTS AND TERMINATIONS: install all incoming and outgoing cable supports, cable ends and termination fittings required for power and control cables. All circuit breakers bolts to be tightened in according to toque level as specified by circuit breaker manufacturer.

3.1.6. RELAYS: set in accordance with manufacturer's instructions and in accordance with an approved scheme.

3.1.7. MAKE GOOD damaged painted surfaces, clean and apply rust-inhibiting prime coat and two finishing coats of approved enamel upon delivery of equipment to site, or as required by the Engineer.

3.2. INSPECTION AND TESTS ON SITE

3.2.1. EQUIPMENT: inspect equipment upon delivery to Site and report any damage to the Engineer.

3.2.2. SWITCHGEAR: inspect and check switchgear for completeness, component ratings, types, sizes, and wiring connections. Check phasing of busbars, contacts and clearances.

3.2.3. TESTS: after installation and before handover, carry out all tests required by the governing codes and any other tests the Engineer may require to check compliance of installation with the Specification, including insulation resistance tests and operational tests.

3.2.4. MAIN AND CONTROL CIRCUITS: using 1000 V megger (2000 Megohm range), check insulation resistance between phases, between phases and earth/enclosure and between neutral and earth.

3.2.5. PRIMARY INJECTION TESTS: provide portable test equipment to test time-delay characteristics of circuit breakers by simulating an overload or fault condition. Measure and record all test results and ambient conditions and compare with manufacturer's data.

3.2.6. INSTANTANEOUS TRIP ELEMENTS: test by high current primary injection, using high-current primary injection test-sets and report all readings.

3.2.7. ROUTINE TESTS ON SITE are to be carried out on every main distribution board in accordance with the Standard specified (IEC 439 or BS 5486: Part 1) for FBAs assembled from standardized components outside the works of the manufacturer. Routine tests are also to be carried out on every FBA, delivered to site, if requested by the Engineer.

END OF SECTION

SECTION 16440

WIRING DEVICES AND DISCONNECTORS

PART 1 GENERAL

1.1 Related Documents

Drawing and general provisions of the Contract, including General Conditions, Conditions of Particular Application and Division-1Specification Sections, apply to work of this section.

1.2 Summary

This section shall cover various types of receptacles, connectors, switches and finish plates

Submittal

Submit the following according to the Conditions of the Contract and Division 1 Specification Sections:

- Product Data: Data shall be submitted for each product specified in this section, with catalog clippings and manufacturer technical specifications.

- Samples Provide three (3) samples for each device which shall be used and for all relevant accessories (cover, plates). Color selection and technical features shall be complied with the requirements of codes and of the Engineer.

- Operation and Maintenance Data: Provide operation and maintenance data for materials and products specified in this section.

1.4 Quality Assurance

Products shall be supplied from one manufacturer.

Manufacturer shall be regularly engaged in manufacture of electrical devices, sizes, and ratings. These products have been in satisfactory use and in service for not less than 2 years. Products shall be complied with requirements of local codes and IEC Standards.

PART 2 PRODUCTS

2.1 Manufacturers

Approved manufacturers subject to compliance with requirement. Wiring devices shall comply fully with the relevant Local, and International Standards.

All types shall be of the same manufacturer to provide consistent appearance and finish.

2.1 Manufacturers (Cont'd)

Rated voltage and ampere should be indicated on all wiring devices, fixed screen shall be installed to separate live parts in case of multi-phase exists in one box.

Approved Manufacturer
- Legrand Arteor White
  Or approved equal

2.2 Wiring Devices

2.2.1 Boxes and Fittings

Boxes shall be provided with means for securely terminating conduits.

Heavy-molded rigid PVC boxes shall be provided with brass insert threads and fixed lugs to receive cover screws.

Round boxes shall not be used where conduits or connectors requiring the use of locknuts or bushings are to be connected to the side of the box.

2.2.2 Plates

Plates shall be of square or rectangular shape to adequately cover corresponding outlet boxes and be designed to fit the electrical devices, Various samples shall be submitted for approval and/or selection by the Engineer.

Fixing screws shall be chromium plated, polished. Screw head shall suit the plates.

Combination (multi-gang) plates shall be provided for grouped outlets and devices as detailed on the Architectural or Electrical Drawings.

Plates for socket outlet shall match switch plates in each particular area.

The Contractor shall supply a unified standard type socket (receptacle) outlet for the whole project, preference shall be given to French or German type sockets.

Socket outlet shall be rated 15 amp, 16 amp, 20 amp, 30 amp, as noted on drawings and 250 volts with two rounded poles plus earth, 20 mm spacing. The earth terminal of each socket shall be effectively connected to the earth continuity conductor, phase and neutral conductors to the respective terminals.

Socket outlet shall have a moulded plastic or porcelain base and be designed to fit the appropriate plate as required or as approved, before execution, by the Engineer.

Sockets above desks in guest rooms for client use to be multi-standards type.

2.2.3 **Socket (Receptacles) Outlets**

Contacts shall be self-adjusted and have a non-expanding size limiting entry, to prevent permanent distortion.

Where duplex socket outlets are shown on Drawings, two of this type of socket shall be mounted under one common plate.

Weatherproof socket outlets shall be mounted in the box specified with a gasketed, weatherproof cast-metal cover plate, with individual cap over each socket outlet opening and stainless steel mounting screws. Caps shall be tightly closed with st3inless steel springs when socket outlet is not in use.

Door bell push button shall be with label holder.

Outlets for internal use shall generally be of the insulated pattern ivory finish, color to be selected by Engineer. In utility and workshop areas metal clad enclosures and finishes shall be used.

Outlets for exterior use shall be weatherproof pattern enclosed in Glassfibre Reinforced Plastic (GRP) or galvanized metal boxes.

Terminals for 220 V outlets shall each be capable of receiving and satisfactorily connecting two (2) conductors (solid or stranded), each of 4 mm2 minimum.

Contact pressure with conductors shall preferably be by clamp plate rather than by pinch screw.

Socket outlets for flush fitting shall be mounted in appropriate recessed box.

Socket outlets and their enclosures shall be complete with necessary terminals for the connection of circuit protective conductors as required by the IEE Regulations and IEC latest edition.

Boxes providing enclosure and/or mounting for socket outlets shall be PVC if concealed or galvanized steel if exposed complete with conduit entries.

2.2.4 **Power Outlets**: Industrial. pattern socket outlets shall comply with IEC 309-2 and shall be fitted with a switch interlock and fuse. Unless specifically detailed, 3 phase with neutral and earth , 380 V sockets shall be fitted. Rating of power socket and number of poles shall be according to the Drawings and/or data sheets.

Power sockets shall be IP 55, made of high tech polymer material, water resistant and supplied with its compatible plug. Earth pole shall be 6 h for all kind of power sockets.

2.2.5 **Load Break Switches (LBS) or Disconnect Switch**

Load break switches shall be provided and installed as shown on Drawings and on wiring schedules.

Electrical characteristics of load break switches such as Ampere rating and number of poles shall be as indicated on Drawings, wiring schedules and/or as herein specified: Ratings have to be readjusted by the Contractor and approved by the Engineer before ordering if the served load is different than that shown in wiring schedules.

The LBS shall be a non-fusible, single-throw, as indicated on Drawing, provided with arc quenching devices on each pole, making it capable of interrupting at least six times the normal switching current.

Switches shall effectively interrupt the power supply for all line conductors where it exists, and simultaneously disconnect the supply for control circuits.

The operating mechanism shall be quick-make, quick-break with the external operating handle mechanically interlocked with the enclosure cover.

Interlocks shall make it necessary for the switch to be in the "OFF" position for normal access to the inside of the enclosure. Switch shall have means of by-passing the interlocks.

Any LBS shall be so placed that gravity shall not tend to close when approved for use in the inverted position**,** it shall be provided with a locking device that will ensure that the blades remain in the open position when so set.

Indication to the position of the switch shall be positive and clearly indicated on the cover.

Enclosure shall be EEC type IP40 for general purpose application, unless otherwise noted and IP65 for weatherproof installations unless otherwise required.

Enclosure shall have provisions for locking the operating handle in the "OPEN" and "CLOSED" positions.

2.3 **Touch-up Paint**

The surface of all hiring devices shall be of the manufacturer's finish according to location and the Engineer approval.

2.4 **Factory Inspection and Testing**

Prior to shipping, all units shall be inspected and shop tested to assure proper operation and compliance of the wiring devices with the requirements of specifications. The inspection and testing shall be in accordance with equipment standards. In addition, all tests shall be complied as specified in the specification sections describing the devices.

PART 3 **EXECUTION**

3.1 **Installation**

3.1.1 General: Flush-mounted boxes shall be cast in concrete walls and grouted into hollow walls. Metal boxes threaded to raceways in exposed installations shall be separately supported.
Boxes installed in concealed conduit or raceway systems shall be set flush with the finished surfaces. The location of all boxes shall be easily accessible and any

interference with mechanical equipment or structural features shall be relocated as directed by the Engineer.

3.1.2 Sockets: The sockets shall be located and installed as shown on the Drawings. The location shall be easily accessible. Receptacles shall be so installed that the neutral (grounded) pin is always on the left side or top side,
when viewed facing the installation.

3.1.3 Switches:Local wall switches near doors, shall be located at strike side of doors as finally hung, whether so indicated on Drawings or not.

A junction box shall be placed in the back of each wall mounted switch or socket outlet.

If thickness of wall does not permit such an installation, adjacent position shall be accepted.

The switches shall be installed as shown on the approved Drawings. Where more than one switch is shown for one indoor outlet box, the switches shall be installed under one plate. Toggle switches for lighting, except for 3-way and 4-way switches shall be installed so that the contacts are closed when the handle is in the up position.

Switches shall be mounted with longer dimension vertical and operating handle in upward position when in the "ON" position.

Single pole switches shall switch the (phase) wire circuit. Neutral wire shall not run through switches provided with a neutral shunt or bridge.

3.1.4 Device Plates: Device plates shall be installed with all four edges in continuous contact with finished wall surfaces without the use of mats or similar devices. device plates shall be installed vertically with an alignment tolerance of 0. 16 mm (1/16 inches).

3.1.5 Mounting Height: The mounting height of wall-mounted outlet and switch boxes; measure between the bottom of the box and the finished floor, shall be as specified and as approved by Engineer.

3.2 Grounding

Grounding system shall be installed as required by the drawings, and as specified hereln. Neutral conductors of the wiring system shall be grounded at the transformer secondaries and at the panelboards, the grounding connections shall be made as indicated on Drawings, and as required by the IEC Code.

Devices grounding connections shall be made by means of screw-type pressure connectors to the box's frame and receptacle ground pin in accordance with the IEC Code.

3.3 Field quality Control

Provide checking, adjusting and testing operations on the wiring devices installation including the following:

Check: All wire terminals shall be checked to assure tight connections, electrical continuity and for short circuit.

Operate each device at least 6 times. All wiring services shall be clean before energizing.

- Adjust: Adjust wiring devices to operate in the indicated and required sequence.
- Testing: The tests shall be performed to detect wrong connections, short circuits, continuity,

Test wiring devised for proper polarity and ground continuity.

Replace damage or defective components.

END OF SECTION

SECTION 16452

EARTHING SYSTEM

1. GENERAL

1.1. ELECTRICAL WORK GENERALLY is to be in accordance with the requirements of Section 16010 of the Specification.

1.2. DESCRIPTION OF WORK: complete installations to earth every source of energy and to provide protective earthing and equipotential bonding, based on the TNS system arrangement, including:

transformer neutral earthing.

main earthing terminals or bars.

exposed conductive parts of electrical equipment.

extraneous conductive parts.

standby generator neutral earthing.

1.3. REGULATIONS AND STANDARDS: carry out work in accordance with the following:

1.3.1. IEC publications 364-3 and 364-4-41 Electrical Installations in Buildings

1.3.2. latest edition of IEE Regulations for Electrical Installations in Buildings - London.

1.4. DEFINITIONS OF TERMS used on the Drawings and in the Specification are as follows:

1.4.1. EARTH: conductive mass of the Earth whose electric potential at any point is conventionally taken as zero

1.4.2. EARTH ELECTRODE: conductor or group of conductors in initial contact with, and providing electrical connection to, Earth

1.4.3. EXPOSED CONDUCTIVE PART: any part which can be readily touched and which is not a live part, but which may become live under fault conditions

1.4.4. EXTRANEOUS CONDUCTIVE PART: any conductive part not forming part of the electrical installation such as structural metalwork of a building, metallic gas pipes, water pipes, heating tubes etc. and non-electrical apparatus electrically connected to them i.e. radiators, cooking ranges, metal sinks etc. and non-insulating floors and walls.

1.4.5. PROTECTIVE CONDUCTOR: conductor used for some measure of protection against electric shock and intended for connecting together any of the following parts:

exposed conductive parts

extraneous conductive parts

earth electrode(s)

main earthing terminal or bar(s)

earthed point of the source(s)

1.4.6. ELECTRICALLY INDEPENDENT EARTH ELECTRODES: earth electrodes located at such distance from one another that maximum current likely to flow through one of them does not significantly affect the potential of the other(s)

1.4.7. MAIN EARTHING TERMINAL OR BAR: the terminal or bar provided for the connection of protective conductors, including equipotential bonding and functional earthing conductors if any to the means of earthing.

1.4.8. EQUIPOTENTIAL BONDING: electrical connection to put exposed and extraneous conductive parts at a substantially equal potential.

1.4.9. EARTHING CONDUCTOR: protective conductor connecting main earthing terminal or bar of an installation to earth electrode or to other means of earthing.

1.5. EQUIPMENT DATA: prior to ordering materials, submit data for approval including, but not limited to, manufacturer's catalogues for earth rods, connecting clamps, earthing conductors, protective conductors, bonding conductors, connectors and other accessories, exothermic welding kits and tools etc., and samples of conductors as requested.

1.6. SHOP AND CONSTRUCTION DRAWINGS: submit drawings for approval including, but not limited to, the following:

A. exact location of earth pits, rods and details of installation and connections.

B. exact routing of buried earthing conductors with indication of cross-section, depth of laying and covering.

C. cross sectional area of all earthing, protective and bonding conductors.

D. layout and details of earthing provisions at substations, generator rooms, switchgear, distribution panelboards etc., indicating fittings used, insulation, plates and marking, passage and routing of earthing conductors, conduit, sleeves, grooves, niches etc., giving sizes and dimensions of component parts.

1.7. APPROVED MANUFACTURERS: obtain materials from one of the following:

Kingsmill	(England)
Copperweld	(U.S.A.)
Furse	(England)
OBO Bettermann	(Germany)
Wallis	(UK)

or other equal and approved.

2. PRODUCTS AND SYSTEMS

EARTHING SYSTEM (TYPE TT)

2.1. GENERAL REQUIREMENTS

2.1.1. COMPONENT PARTS of earthing system are to include the following:

earth electrode (rods, tapes etc.)

main earthing terminals or bars

earthing conductors

protective conductors

equipotential bonding conductors

electrically independent earth electrodes for special systems

accessories and termination fittings, bonding, welding kits and other materials.

2.1.2. EARTH ELECTRODE is to consist of one or more earth rods, interconnected by buried earthing tape or cable, which is to have a total combined resistance value, during any season of the year and before interconnection to other earthed systems or earthing means, not exceeding 5 ohms. Distance between two rods is not to be less than twice the length of one rod driven depth.

2. PRODUCTS AND SYSTEMS (CONT'D)

2.1.3. RING TYPE EARTH ELECTRODE is to consist of earthing conductors, in a closed loop, buried in exterior wall foundations underneath the water-proofing, or alternatively at 0.6 m around the perimeter of the building foundations, as shown on the Drawings, to which all earthing conductors are to be connected. Insulated connection flags into the building, of same material as earthing conductors, are to be located at positions of service entrance and main switchboard rooms, terminating in bolt-type earth points (studs) or test-links for connection of main earth bar(s). Additional earth rods

connecting with the earth ring are to be provided, as necessary, to bring down earth electrode resistance to an acceptable value.

2.1.4. FUNCTIONAL EARTH ELECTRODE is to be provided separately from, but interconnected to, other earth electrode(s) through suitably rated (470 V) spark gap. Functional earth electrodes are to be used for earthing electronic equipment (communication equipment, digital processors, computers etc.) as required by the particular Section of the Specification and recommendation of manufacturer.

2.1.5. ALTERNATIVE EARTH ELECTRODE: other types of earth electrode may be used, after approval, including:

A. cast iron pipes with special surround material

B. plate(s)

C. tape mats (strips).

D. MAIN EARTHING BAR is to be provided at point of service entrance or main distribution room, and as described in the Specification or shown on the Drawings, to which all earthing conductors, protective conductors and bonding conductors are to be connected. Two insulated main earthing conductors are to be provided, one at each end of the bar, connected via testing joints to the earth electrode at two separate earth pits. Conductor is to be sized to carry maximum earth fault current of system at point of application with final conductor temperature not exceeding 160 deg. C for at least 5 seconds. Main earthing conductors are to be minimum 120 mm^2 or as otherwise required by the particular Section of the Specification.

E. TESTING JOINTS (TEST LINKS) are to be provided, in an accessible position, on each main earthing conductor, between earthing terminal or bar and earth electrode.

2. PRODUCTS AND SYSTEMS (CONT'D)

F. PROTECTIVE CONDUCTORS are to be separate for each circuit. Where protective conductor is common to several circuits, cross-sectional area of protective conductor is to be the largest of the conductor sizes. Selection of sizes is to be in accordance with Table 54F of IEE Regulations.

G. PROTECTIVE CONDUCTORS are not to be formed by conduit, trunking, ducting or the like. Where armoured cable is specified and armour is steel, it may be used as a protective conductor, if approved and if not otherwise shown on the Drawings.

H. CONTINUITY OF PROTECTIVE CONDUCTORS: series connection of protective conductor from one piece of equipment to another is not permitted. Extraneous and exposed conductive

parts of equipment are not to be used as protective conductors, but are to be connected by bolted clamp type connectors and/or brazing to continuous protective conductors which are to be insulated by moulded materials.

I. EARTH FAULT LOOP IMPEDANCE: for final circuits supplying socket outlets, earth fault impedance at every socket outlet is to be such that disconnection of protective device on overcurrent occurs within 0.4 seconds, and for final circuits supplying only fixed equipment, earth fault loop impedance at every point of utilization is to be such that disconnection occurs within 5 seconds. Use appropriate tables and present same for approval by the Engineer (IEE Regulations: Tables 41A1 and 41A2, Appendix 7 and Regulation 543).

J. SUPPLEMENTARY EQUIPOTENTIAL BONDING: all extraneous conductive parts of the building such as metallic water pipes, drain pipes, other service pipes and ducting, metallic conduit and raceways, cable trays and cable armour are to be connected to nearest earthing terminals by equipotential bonding conductors. Cross-section of protective bonding conductor is not to be less than half that of the protective conductor connected to respective earthing terminal, and minimum 4 mm^2.

K. IDENTIFICATION: connection of every earthing conductor to earthing electrode and every bonding conductor to extraneous conducting parts is to be labelled in accordance with the Regulations, as follows:

L. SAFETY ELECTRICAL CONNECTION - DO NOT REMOVE.

M. IDENTIFICATION: protective and earthing conductors are to be identified by combination of green-and-yellow colors of insulation or by painting bar conductors with these colors, as approved.

N. IDENTIFICATION: source earthing conductor (or neutral earthing conductor) is to be identified along its entire length by continuous black insulation labelled 'neutral earthing'.

2.2. TRANSFORMER SUBSTATION EARTHING

Not applicable

2.2. TRANSFORMER SUBSTATION EARTHING (BY EDL)

2.2.1. TRANSFORMER NEUTRAL

Not applicable

2.3. EARTHING OF MAIN DISTRIBUTION BOARDS, PANELBOARDS, LIGHTING INSTALLATIONS AND WIRING ACCESSORIES

2.3.1. MAIN EARTHING BAR is to be provided in main distribution room and connected to earth electrode by two insulated conductors (minimum 120 mm²) via testing joints.

2.3.2. EARTHING BARS OF MAIN DISTRIBUTION BOARDS are to be connected, by bare earthing conductor, directly to main earthing bar at main distribution room and by protective conductor run with incoming feeder from respective supply point.

2.3.3. DISTRIBUTION, LIGHTING AND POWER PANELBOARDS are to be connected by protective conductors run together with incoming feeder cable, connecting earth terminals in panelboards with respective main distribution board earthing bar.

2.3.4. SOCKET OUTLETS are to be earthed by protective conductor looped around with the branch circuit and connected to earth terminal within socket outlet box and to which socket outlet terminal is to be connected.

2.3.5. FINAL RING SUBCIRCUITS: protective conductor of every final ring subcircuit is to be in the form of a ring having both ends connected to earth terminal at origin of circuit in panelboard.

2.3.6. LIGHTING FIXTURES AND OTHER EXPOSED CONDUCTIVE PARTS of electrical installations, such as switches, heaters, air conditioning units etc. are to be connected by protective earth conductors to earthing terminals of respective panelboards.

2.4 GENERATOR PLANT EARTHING

2.4.1. GENERATOR NEUTRAL

Connected to earthing system.

2.4.2. EXTRANEOUS CONDUCTIVE PARTS including steel frames, battery racks, day-tank, pumps and piping are to be connected by bare copper earthing conductors to main earth bar in compliance with bonding regulations.

2.4.3. Lightning Arresters are to be connected to the bus bar of the panel it is protecting, distance between arrester & earth bar plus distance between arrester & main breaker of panel should be < 0.5m.

2.5. MECHANICAL PLANT ROOMS AND FIXED MACHINERY

2.5.1. MAIN EARTHING BAR OR LOOP is to be conveniently located in mechanical plant rooms, and connected by earthing conductors to exposed conductive parts of motor control centre at its earthing bar, and to motors, switches and other electrical equipment etc. at their

earthing terminals, using 20 x 2 mm bare copper strips or 35 mm² bare copper conductor (minimum size) or as required to carry maximum earth fault current for 1 second with final conductor temperature not exceeding 200 deg. C. Conductors are to be securely fixed, recessed in floor grooves or niches, or fixed to walls by appropriate staples. Earth bar or loop is to be securely fixed to building wall with copper or brass saddles.

2.5.2. MAIN EARTHING BAR OR LOOP is to be connected at two extremely separate points to earth electrode, directly through two test joints by insulated earthing conductors, or connected to main earth bar by protective conductors.

2.5.3. MOTOR AND OTHER EQUIPMENT EARTH TERMINALS are to be connected also by protective earth conductors of each branch circuit to earth terminal/bar at motor control centre, panel or distribution unit.

2.6. ROAD LIGHTING (when applicable).

2.6.1. EARTHING CABLES: separate protective earthing cables for lighting column circuits are to be run with power circuit, terminated at LV supply position in lighting control panel and looped into column earthing terminals. Every column is to be bonded via an earthing bolt to a single 14 mm diameter copper covered steel rod, 2.5 m long, driven into ground adjacent to column. Bonding is to be 16 mm² stranded bare copper conductor.

2.6.2. CONNECTIONS between rods and earthing conductors are to be made by the Cadweld process producing a fused joint. Bolted connections may be used for connection to removable items of equipment only.

2.7. MATERIALS AND PRODUCTS

2.7.1. EARTH ROD: Non Corrosive stainless steel, 20 mm diameter, 3 m length, extendible as necessary to obtain required earth resistance. Earth rod is to be complete with couplings, head and bolted connector of sufficient size, and number of bolted clamps to connect all cables terminated thereto.

2.7.2. BURIED EARTH CONDUCTORS: bare annealed Non corrosive stainless steel strip conductors 25 x 2.5 mm, or annealed stranded stainless steel 95 mm² cross-section.

2.7.3. TAPE MATS: where earth rods are not likely to be used, earth electrode is to consist of parallel and perpendicular copper strip, 2.4 m

apart, welded together by exothermic welds to form a grid. Tape is to be 25 x 2.5 mm strip conductor.

2.7.4. EARTH PIT: precast, square or circular section concrete handhole (minimum 450 mm internal diameter), with concrete cover, and extending to about 150 mm below top of earth rod. Earth pit is to be provided for each earth rod where connected to an earthing conductor. Cover is to have inset brass plate with inscription 'Earth Pit - Do Not Remove'.

2.7.5. EARTHING CONDUCTORS: insulated or bare copper conductor as described in the Specification for the particular application.

2.7.6. TESTING JOINTS (TEST LINKS): copper, stainless steel or copper alloy as applicable, with bolted end connections, disconnectable by use of a tool, and suitably sized for earthing conductors or earth bar connection. Links are to be fixed to porcelain or other approved insulating supports. Contact surfaces are to be tinned.

2.7.7. PROTECTIVE CONDUCTORS: single core stranded annealed copper, PVC insulated cables, having rated insulation grade compatible with circuit protected, or to be a conductor forming part of a multi-core cable, color coded.

2.7.8. MAIN EARTHING BAR: hard drawn copper, 40 x 4 mm where formed into a closed loop, and 50 x 6 mm where open ended. Earth bar is to be labelled 'Main Earth Bar' and is to be drilled, for connection of conductors, at a spacing not less than 75 mm, and is to be supplied with copper alloy bolts, nuts and washers and wall mounting insulators.

2.7.9. PROTECTIVE BONDING CONDUCTORS: bare copper strip conductor, annealed stranded copper cable or flexible strap (flexible braid) of cross-sectional area as described in sub- section 1 hereof.

2.7.10. EARTHING ACCESSORIES: copper or copper alloy, purpose made, of approved design, compatible with points of connection, and of adequate cross-section and current carrying capacity. Connectors and clamps are to be bolted type. Bolts, nuts and washers are to be high quality phosphor bronze or copper silicon alloys.

3. FIELD AND INSTALLATION WORK

3.1. INSTALLATION

3.1.1. CONTINUITY: ensure that complete earthing system is electrically continuous and mechanically secure.

3.1.2. EARTH RODS: while sitting earth rods, ensure that resistance areas associated with individual rods do not overlap. Earth rods are to be

located at a distance greater than 600 mm from foundations of buildings. Where rock is encountered, a hole of sufficient size is to be drilled before lowering the rod. Conductive filler such as Marconite or Bentonite or equal filler that will not corrode, is to be provided around the rod.

3.1.3. BURIED EARTHING CONDUCTORS are to be laid at a depth not less than 0.8 m from ground surface.

3.1.4. EARTHING CONDUCTORS are to follow shortest path between earth rods and main earthing terminals or bars, and are to run in PVC conduit (duct) fastened to building structure by approved supports and extending 0.2 m above level, and are to be protected against mechanical damage and corrosion.

3.1.5. PROTECTIVE CONDUCTORS: separate protective conductors, which are not part of a cable, are to be fixed on same support or drawn into same conduit as circuit conductors.

3.1.6. PROTECTIVE BONDING: remove any non-conductive paint, enamel or similar coating at threads, contact points and surfaces and ensure that bonding is made by fittings designed to make secure bonds.

3.1.7. PROTECTION AGAINST CORROSION: protect bolted connections against corrosion either by filling with vaseline or coating with a special anti-corrosion compound and proper capping.

3.1.8. CONNECTIONS: earth connections are to be readily accessible. If inaccessible earth connection is permitted, approved exothermic welding or brazing technique is to be employed.

3.1.9. CONNECTIONS: where earth connections between dissimilar metals must be made, use bimetallic fittings and protect by coating with moisture resisting bituminous paint or compound, or by wrapping with protective tape to exclude moisture.

3.1.10. LIGHTNING ARRESTERS are to be directly connected to earth bar of the panel it is protecting, following the shortest path (distance between arrester and earth bar plus distance between arrester and main breaker < 0.5 m).

3.2. TESTS ON SITE AND RECORDS

3.2.1. COMBINED RESISTANCE of earth electrodes is to be measured during dry season and checked against specified resistance.

3.2.2. ELECTRICAL CONTINUITY of all earthing and protective conductors including main and supplementary equipotential bonding conductors is to be checked.

3.2.3. EARTH FAULT LOOP IMPEDANCE of all circuits is to be measured and checked against calculated impedance figures.

3.2.4. OPERATION of residual current protective devices is to be checked.

3.2.5. RECORDS: submit the following:

A. scaled drawings, as-installed, showing actual layout and specification of all components of earthing system

B. nature of soil and any special earth arrangements etc.

C. date and particulars of soil conditioning method and agents if used

D. test conditions and results obtained

END OF SECTION

SECTION 16480

MOTOR STARTERS

PART 1 - GENERAL

1.01 SUMMARY

A. Provide labor, materials, equipment and services, and perform operations required for installation of motor starters and related work as indicated on the drawings and specified herein.

Work Included: The work shall include, but not be limited to, the following:

1. Combination motor starters.

2. Fractional HP manual motor starters.

C. Related Work Specified Elsewhere

1. Basic Electrical Requirements - Section 16910

2. Circuit and Motor Disconnects - Section 16170.

3. Electrical Identification - Section 16195.

4. Motor Control Centres - Section 16482.

1.02 QUALITY ASSURANCE

A. Materials and equipment shall conform to the latest edition of reference specifications specified herein and to applicable codes and requirements of local authorities having jurisdiction.

1. Electrical Code Compliance: Comply with applicable electrical code requirements of the authority having jurisdiction.

1.03 SUBMITTALS

A. Submit the following in accordance with the requirements specified under "Submittals" in section 16010.

1. Product Data: Submit manufacturer's and installation instructions on motor starters.
2. Shop Drawings: Submit shop drawings of motor starters.
3. Wiring Diagrams: Submit power and control wiring diagrams for motor starters. Differentiate between portions of wiring, which are manufacturer-installed, and portions, which are field-installed.

1.04 DELIVERY, STORAGE AND HANDLING

A. Deliver materials and equipment specified herein in manufacturer's unopened containers, with manufacturer's name and point of origin on each container.

B. Deliver materials and equipment and handle as to prevent the inclusion of foreign materials and the damage of materials by water or breakage.

C. Store materials and equipment in clean dry place and assume responsibility and security for materials and equipment. Take precautions for protection from detrimental conditions.

1.05 SEQUENCING AND SCHEDULING

A. Sequence motor starter installation work with other work to minimize possibility of damage and soiling during remainder of construction period.

1.06 MAINTENANCE

A. Maintenance Data: Submit maintenance data and parts list for each motor starter and component; including "troubleshooting" maintenance guide. Include that data, product data and shop drawings is a maintenance manual; in accordance with requirements of Section 16010.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Subject to compliance with requirements, provide motor starters of one of the following (for each type and rating of motor starter):

1. Schneider
3. Moeller.
4. Katko.
5. Or approved equal

2.02 MATERIALS AND EQUIPMENT

A. Disconnect Type

1. Disconnects shall be of the molded case circuit breaker, bolt-on type as specified.

B. Motor Starters

1. Except as otherwise indicated, provide motor starters and ancillary components which comply with manufacturer's standard materials, design and construction in accordance with published product information and as required for installation.

2. Equipment shall be the product of one manufacturer, unless located in a hazardous location, to insure standardization of spare parts, operation and maintenance.

3. Where motors furnished by the Contractor (subject to Engineer's approval) differ from the ratings indicated, the Contractor shall provide the required adjustments to wiring, conduit, disconnects, starters and protection as required.

4. Provide externally manually reset type thermal overload protection in each phase, located within the starter, and selected on the basis of the actual full load nameplate current rating of the motor, taking into account the reduction in current if capacitors are installed downstream of the overload protection.

5. Provide an individual control power transformer within each motor starter for motors, operating at voltages above 120 volts. Secondary voltage of the control power transformer shall be 120 volts, fused on one side and grounded on the other side. Do not connect switching contacts in the grounded side of the control circuits. Rating of the control transformers shall be adequate for imposed control devices 120 volts operating coils, pilot lamps, relays, etc. Provide primary fuse protection where required by the applicable electrical code.

6. Provide a minimum of two normally open and two normally closed auxiliary contacts (two convertible contacts are acceptable)in addition to a normally open "seal-in" contact. Where the required number of auxiliary contacts (spare plus active) cannot be mounted on the starter contractor, provide control relays within the starter enclosure.

7. Starters shall be enclosed. Enclosures shall be as requirements of IEC for indoor and outdoor, unless otherwise noted. Where installed in hazardous location, enclosures shall be suitable and as approved for the class, division and group in the classified area.

8. Minimum size of starter shall be as per requirements of IEC.

9. Starter contacts shall be as requirements of IEC rated. Where starters are utilized with high efficiency, high power factor motors, contacts shall be suitable for the higher than usual inrush currents associated with these motors.

10. Provide combination magnetic full voltage (across-the-line) single speed non-reversing starters unless otherwise indicated.

11. Motor starter panel enclosures and breakers shall abide by applicable paragraph of specifications in section 16116.

    Motor Starters shall be built and sized in accordance with NEMA Industrial Control Standards, ICS-1970 or IEC 947 or approved equal.

Starters shall be non-reversing, magnetic type unless otherwise indicated or specified.

All starters shall be equipped with necessary control contact for connection to BMS.

Contactors shall have their contact easily accessible for inspection and maintenance.

It shall not be possible to remove the arc-quenching chamber when the contactor is energised.

The arc-quenching chamber shall be fully enclosed in order to prevent the escape of hot gases.

It shall be impossible to operate the main and auxiliary contacts manually by means of the position indicator.

Auxiliary switches shall be equipped with fail-safe linkage in order to exclude false signals.

The rated withstand voltage shall be 600 V and the test voltage shall be 3000 V for 1 minutes (IEC 9471).

The insulation class coil shall be "B" according to VDE 0660.

All starters shall comply with coordination type 2 per IEC 947-4-1 when installed in MCC, MSP, or PCP.

All starters shall be provided with thermal cutout devices in each phase calibrated for close protection of the motors against overloads. These devices shall trip the starters in case of overload and shall not allow it to be reset except manually. The thermal overload relays shall be adjustable from 90 to 110% of nominal rating. A single calibration adjusts all three legs. The overload relay shall be ambient compensated.

All motors 10 HP and larger shall have their starters equipped with integrated multiple function solid state motor protection for:

- Thermal overload
- Assymetry/ phase failure
- High overload/stalling

Motor starters larger than 20 hp. shall also have earth fault protection integrated within the solid state motor protection unit.

THE STARTER SHALL BE PROVIDED WITH AUXILIARY CONTACTS FOR THE CONNECTION OF SIGNALING, INTERLOCKING AND OTHER CIRCUITS AS REQUIRED FOR

THE CONTROLS.(AT LEAST 2 NO. + 2 C) AND AS REQUIRED BY BUILDING MANAGEMENT SYSTEM.

Unless otherwise indicated, all starters shall be provided with START-STOP pushbuttons, and RED & GREEN pilot lights, all located on the starter front cover. An overload reset button shall be provided inside the cover. Pushbuttons shall be momentary contact or maintained type as applicable to the function of control.

Starters shall have horsepower ratings at least equal to ratings of motors they serve.

Voltage of control circuit shall not exceed 220 volts.

Starters shall be electrically held in, providing inherent undervoltage release.

Starters when not part of a motor control center and are located indoors shall be encased in a NEMA 1 gasketed dust-proof enclosure, unless otherwise indicated.

"Star-delta" starters if any shall have additional "Star" and "Delta" contactors which shall be electrically and mechanically interlocked to close the motor in "Delta" connection with the supply after the "Star" contactor has opened. A timing device shall be fitted to provide and adjust time in "Star" before changing over to the Delta connection.

"Star-Delta" Starters shall provide close transition.

Schematic wiring diagram of all starters shall be provided on the interior of starter front cover.

Auto-transformer type starter shall not be approved.

C. Motor circuit protective device

Motor circuit protective devices shall comply with IEC standards 957-1 and 957-2. Alternative proposals to ratings shown on drawings based on manufacturers recommendations shall be subject to the Engineer's Approval. The Contractor shall in any case be responsible to assure that the circuit protective devices shall carry the starting current with no tripping, and if reducing trip rating results in a reduction in frame size, the Contractor shall make sure that the new rating withstands the available short circuit current.

D. Control Panel

Control panel of individual air handler units shall consist of individually mounted combination starters and shall also include all additional control and instrumentation devices as described under corresponding clause in mechanical section.

E. Combination Starters

Combination Starters shall comprise motor starters as specified hereinbefore and a moulded case circuit breaker in a NEMA 1 enclosure unless otherwise indicated. The circuit breaker may be a magnetic only type in lieu of thermal magnetic to the approval of the Engineer.

Combination starters shall be manufactured by GE (USA), ABB

F. Solid-State Reduced Voltage Motor Starter (Soft Starter)

Solid state , soft starter shall be used where indicated on drawings and shall be quoted separately as an alternative to star-delta starter.

1. The solid-state reduced voltage motor controller shall consist of a power section, a one-piece printed circuit logic board and a field wiring interface terminal board.

2. The power section shall be three-phase, 50 Hz. and rated for the hp, current, and voltage as shown on the drawings. It shall consist of three sets of back-to-back phase controlled power semi-conductors. Maximum current limit shall be 500% for standard units.

3. Resistor/Capacitor snubber networks shall be used to prevent false firing of SCR'S due to dv/dt characteristics of the system.

4. Fan cooled units shall be supplied with thermal sensors on the heat sink to trip the control protective logic for over-temperature condition. Thermal sensors shall be rated 90 ºC maximum.

5. The one piece logic board shall be mounted for easy testing, service and replacement.

6. Three-phase current sensing via current transformers for closed loop control to insure motor stability shall be provided.

7. The logic board shall used quick disconnect plug-in connectors for current transformer inputs, line-and-load voltage inputs, SCR gate firing output circuits and status panel.

8. The logic circuitry shall include as a minimum:

a. Short circuit electronic trip overcurrent protection. Time not to exceed ½ cycle.

b. Inverse time running overcurrent protection.

c. Auxiliary trip circuitry.

d. Gate firing circuit lockout protection on trip.

e. Fault relay lockout protection.

f. 250%-500% current limit adjustment.

g. Minimum and maximum voltage adjustments.

h. Voltage stability adjustment.

9. The logic board soldering shall be treated with a conformal protective coating system.

10. The logic board shall include, as standard, current and motor slip sensing circuitry that continually monitor motor load and regulate motor voltage to minimize motor kWh energy consumption.

11. The solid-state logic shall provide phase sequence protection.

12. External interface circuitry shall include 220-volt or l120 volt relay logic interface capability.

13. Tripped functions shall be designed to be cleared by removing power from the solid-state logic board.

14. Controllers for motors larger than 200 hp shall have additional features as follows:

a. Dwell time at current limit with ramp continuation after acceleration.

b. Individual light emitting doides (LEDs) to indicate run, undervoltage, phase loss, phase current unbalance, overcurrent trip, overtemprature, current limit, end of ramp and incorrect phase rotation.

c. Single-phase protection with built-in short time delay.

d. Undervoltage protection with built-in short time delay.

e. The power section shall have metal oxide varistor (MOV) type surge suppressors across the SCRs rated 10% above the SCR rated voltage. The power semi-conductors shall be rated with peak inverse voltage at least 2.5 times SCR rated line-to-line voltage. Data shall be made available on tolerances to incoming line voltage surges or line spikes. Data shall include both magnitude and time content of each spike (volgage peaks and volt-seconds) plus tolerance to repetitive surges.

f. 100%-120% full load running current trip adjustment.

g. 200%-500% current limit adjustment.

15. Two ground lugs shall be furnished, one for incoming and one for outgoing ground connections.

16. Power terminations shall consist of pressure type terminals for top or bottom entrance.

17. Enclosure

a. Enclosures shall not be less than 16-gauge steel. Type 12 enclosures shall be of welded construction with gasketed heat sink and doors.

b. Doors shall include plastic device holders for mounting up to six (eight for above 200 hp motors) operator devices.

c. External and internal steel surfaces to be painted shall be thoroughly cleaned and phosphatized prior to application of paint. They shall then be primed with a corrosion-resisting coating. Cabinet and door finish shall be manufacturer's standard.

d. Controllers for motors above 200 hp shall include the following:

1. The operating handle of the disconnect, when supplied, shall always remain connected to the breaker or switch. The operating handle shall not be mouted on the door of the enclosure, but on the controller for safe "stand-aside" operation. The position of the operating handle will indicate ON or OFF position of switch or circuit breaker and include provision for padlocking in the OFF position.

2. Interlock provisions shall prevent unauthorized opening or closing of the starter door with the disconnect in the ON position.

3. The structure, when floor-mounted, shall be provided with adequate lifting means and shall be capable of being rolled or lifted into installation position and bolted to the floor.

4. A door-mounted status panel shall provide individual light emitting diodes (LEDs) to indicate run, undervoltage, phase overtemperature, current limit, end of ramp and incorrect phase rotation.

G. Fractional HP Manual Starters

Fractional HP Manual Starters: Single-phase fractional HP manual motor starters, of sizes and rating indicated. Equip with manually operated quick-make, quick-break toggle mechanism; and with one-piece melting alloy type thermal units. Starter to become inoperative when thermal unit is removed. Provide starters with double break silver alloy contacts, visible from both sides of starter; green pilot lights, and switch capable of being padlocked-OFF. Enclose starter unit in IEC general purpose enclosure suitable for flush mounting in finished areas and surface mounting in non-finished areas. Where installed in

hazardous locations, enclosure shall be suitable and approved for the class, division and group in the classified area. Coat with manufacturer's standard color finish.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine conditions at the job site where work of this Section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

3.02 PREPARATION

A. Examine the Contract Drawings and specifications in order to insure the completeness of the work required under this Section.

B. Verify measurements and dimension at the job site and cooperate in the coordination and scheduling of the work of this Section with the work of related trades, so as not to delay job progress.

C. Provide templates as required to related trade for location of items.

3.03 INSTALLATION

A. Install motor starters as indicated, in accordance with equipment manufacturer's written instructions and with recognized industry practices; comply with applicable requirements of the applicable Electrical Code, IEC standards, to insure that products fulfill requirements.

B. Provide disconnect switches at motors where shown on the drawings or where required by the applicable electrical code.

C. Install equipment at uniform heights with operating means at convenient heights above the floor.

D. Wire motors, starters and controls in accordance with approved wiring diagrams. Do not use freehand field wiring diagrams or sketches.

E. Examine motors for presence of moisture prior to installation. Refer any doubtful condition to Engineer for decision.

F. Support starter enclosures independent of the connecting conduits.

G. Do not use connecting conduits to support starter and/or control enclosures.

H. Check control wiring for proper connection before energizing by "ringing" or "taking" out circuits.

I. Refer to the Heating, Ventilating and Air Conditioning and Plumbing drawings and specifications for the manner of control, operation and monitoring of motors and other electrically operated equipment. Provide a motor starter for each motor and each electrically operated piece of equipment except where motor starters and controls are furnished by the manufacturer of the motor or piece of equipment. Motor starters shall be internally wired and connected to other motor starters and to controls to provide the required control operation and monitoring. Connect motor starters and controls furnished by the manufacturers of motors and other electrically operated equipment.

J. Tighten connectors and terminals, including screws and bolts, in accordance with equipment manufacturer's published torque tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals to comply with tightening torques specified applicable Electrical Code.

K. Grounding: Provide equipment grounding connections for motor starter equipment as specified. Tighten connections to comply with tightening torques specified in IEC to assure permanent and effective grounding.

3.04 FIELD QUALITY CONTROL

A. Prior to energizing motor starters, perform tests as specified in Section "Electrical Tests".

B. Touchup scratched or marred enclosure surfaces to match original finishes.

3.05 ADJUSTING AND CLEANING

A. Adjust operating mechanism, where necessary, for free mechanical movement.
B. Touch up scratched or marred enclosure surfaces to match original finishes.

END OF SECTION

SECTION 16670

LIGHTNING PROTECTION SYSTEMS

1. GENERAL

Electrical work generally is to be in accordance with the requirement of sections 16010 of this specification.

1.1 Description of Work

Complete installation of the Lightning Protection System as shown on the drawings, consisting of: 1 early streamer emission air terminal, 2 flat down-conductors and 2 Earthing Systems.

1.2 Regulations and Standards

All work shall be carried out in accordance with the following:

- NFC 17-102

1.3 Submittals

Prior to installation, submit data for approval including, but not limited to manuals, catalogs, head radii protection, exact location of head, down-conductors and earthing system.

The contractor shall also submit drawings showing all details needed for the system, as well as location of each component of the system such as air terminal, down-conductors vertically and horizontally, earthing system.

A prior survey should be conducted to determine the air terminal head location, the down-conductor path on the building roof and side walls, as well as the earthing systems location and type.

2 Products & Systems

2.1 Air Terminal Head

a- General:

The air terminal head should be of the early streamer emission (ESE) kind and must be installed on the highest point of the supporting structure, it should always be the highest point within the area that it protects.

The protected area shall be as defined on the drawings.

The air terminal head and its down conductor through which lightning currents flows should be made of copper. The rod and the terminal tip should have a conductive cross-sectional area larger than 120mm2

b- Positioning:

The air terminal tip should be at least 4 meters higher than the area that any object it protects, including antennas, cooling towers, roofs, tanks, etc…

The down-conductor is attached to the air terminal conductor by a connecting system located on the support rod. This connecting system consists of a suitable mechanical device providing long-lasting electrical contact.

2.2 Down Conductors

a- General:

Down-conductor is designed to let the lightning current flow from the air termination systems to the earth termination system. The down-conductors should be installed outside of the structure.

Air terminal should be connected to the earthing system by at 2 down conductors as shown on the drawings with 2 earthing pits, with max 5 ohms resistivity in dry season.

Down-conductor should be installed on 2 different main walls. Down-conductors consists of PVC covered, flat cable copper 30x2mm or 25x3mm.

b- **Routing:**

The down-conductor should be installed in such a way that its path is as direct as possible. The down-conductor routing should take into account the earth termination location. It should be along the shortest path without sharp bends or upward sections. The bend radii should not be less than 20cm. For the diverting of down-conductors, bends formed edgewise should preferably be used.

The down-conductor should not be routed along or cross-electrical conduits. However, when electrical conduit crossing is unavoidable, the electrical conduit should be placed inside a metal screen, which extends 1m beyond the point of crossing. The screen should be connected to the down-conductor.

Routing round parapet walls or cornices should be avoided. Provisions should be made to ensure that down-conductor paths are as direct as possible. However, a maximum height increase of 40cm is permissible for passing over a parapet wall with a slope of 45° or less.

The down-conductors should be attached on the basis of three fixings per meter. The fixings should be suitable for the supports and their installation should not alter the roof water-tightness. The fixings should allow for possible thermal expansion of the conductors.

All the conductors should be connected together by means of clamps of the same material, or by solid rivets, soldering or brazing. Drilling through down-conductors should be avoided.

Down-conductors should be protected against the risk of impact by installing sleeves up to a height of 2m above ground level

c- External Cladding:

When the outside of a building or structure has a metal cladding or stone or glass curtain-walls, or in the case of a fixed cladding item, the down-conductor may be attached behind the cladding to the concrete wall or the load-bearing structure.

In such a case, the conductive cladding components and the supporting structure must be bonded to the down-conductor at the top and bottom ends.

As the lightning current has an impulse characteristic, flat conductor should be used instead of the round conductor as shown on drawings.

d- Test Clamp/Disconnect Terminal (or test terminal):

Each down-conductor should be provided with a test clamp used to disconnect the earth termination system for measuring. The test clamp should bear the term "lightning conductor" and the Symbol:

Approved Manufacturers

- Pouyet
- Duval Messien
- France Paratonnerres

or approved equal

3 Equipotential Bonding of Metal Parts & Internal Lightning Protection Installation

3.1. General

When lightning current flows through a conductor, differences of potential appear between this conductor and nearby earthed metal parts. Dangerous sparks maybe produced across the ends of the resulting open loop.

Depending on the distance between the ends of the open loop (down-conductor) and earthed metal part, equipotential bonding may or may not be achieved.

However, equipotential bonding is frequently prefered but not provided in some cases (flammable or explosive piping). The down-conductors are then routed further away than the safety distances. Safety distance is known as the minimum distance at which no dangerous sparks can be produced between a down conductor and a nearly earthed conductive mass.

The equipotential bonding should be provided wherever possible at the closest point by an equipotential conductor, a lightning arrester or a spark gap, between the down-conductor and the component to be put at the same potential and located on the structure, in the structure walls or inside the structure.

3.2 Equipotential Bonding of External Metal Masses

In most cases, a connection using an equipotential conductor is possible. If it is not possible or authorized by the local authorities, the connection must be made using a surge protective device as indicated on drawings for all low current systems.

a- Equipotential Bonding using an Equipotential conductor:

Equipotential bonding should be provided at the following locations:

- Above the ground and underground. All the structure earth terminals should be interconnected.

- Whenever the proximity requirements are not met: when d<s

In such a case, the acceptable equipotential conductors should be of the same type as those used to make down-conductor. They should be kept as short as possible. In the event of a lightning protection system seperated from the structure to be protected, the equipotential bonding should be made at ground level only.

b- Equipotential Bonding using a Surge Protective Device:

An antenna or a small post supporting electrical lines should be bonded at the nearest to the down-conductor, via an antenna-mast spark-gap type surge protective device.

Note: Equipotential conductors should be used to connect internal metal parts to an equipotential bonding bar made and laid out in such a way as to allow easy disconnection for inspection purposes. The minimum cross-sectional area of such conductors should be 16mm² of copper. The equipotential bonding bar should be connected to a point as close to the structure earthing circuit as possible. For large structures, several equipotential bonding bars may be installed provided that they are interconnected.

Active conductors should be bonded to the lightning protection system.

3.3 Surge Arresters

Supply install & connect a complete internal lightning protection system including surge arresters as shown on drawings. Class 1/2 (100KA) lightning arresters shall be installed at incoming feeders of Lebanon Mains Power & generator set. Class 2 (40KA) lightning arresters shall be installed at each lighting panel, distribution panel, elevator panel and any other secondary panel as shown on drawings. 10KA lightning arresters shall be installed at each coaxial cable out of CCTV. 10KA lightning protection arrester shall be installed at each incoming telephone pair.

Approved Manufacturers:
- Dehn
- Obo Bettermann
or approved equal

4 Earth Termination Systems

4.1 General

One earthing system shall be provided for each down-conductor.

To allow for the impulse characteristic of the lightning current and to enhance current draining to earth, while minimizing the risk of dangerous voltage surges within the protected volume, it is also important to pay attention to the earth termination system shape and dimensions and also to the earth termination resistance value.

Earth termination systems should meet the following requirements:

- The resistance value measured using a conventional equipment should be 10 ohms or less. This resistance should be measured on the earthing termination insulated from any other conductive component.

- The wave impedance or inductance value should be as low as possible in order to minimize the back-electromotive force which is added to the ohmic potential rise occurring during the lightning discharge. For this purpose, earth termination systems having a single excessively long horizontal or vertical component should not be used.

The use of a single vertical termination system deeply buried to reach a humid layer of soil is thus not advantageous unless the surface resistively is particularly high.

It should however be noted that such drilled earth termination systems have a high wave impedance when the depth exceeds 20 meters. This calls for the use of a greater number of horizontal conductors or vertical stakes, which must always be perfectly interconnected from an electrical standpoint. Similarly, copper conductors should be preferred to steel conductors whose cross-sectional area required to achieve equivalent conductivity makes their use impracticable.

Earth termination systems should be made and laid out as stated above and in section 544 of standard NF C 15-100.

5 Anticorrosion Protection

5.1 General

The corrosion of metals depends on the type of metal used and on the characteristics of the metal environment. Factors such as fungus, soluble salts (electrolytes), degree of ventilation, electrolyte temperature and changes make the conditions highly complicated.

The contact of dissimilar metals associated with electrolysis phenomena due to the environment increases corrosion in more anodic or active metal and decreases corrosion in more cathodic or inert metal. Corrosion in more cathodic metal should be prevented. The electrolyte for this reaction maybe a humid soil or condensation retained in cracks.

5.2 Precautions & Measures to be taken

In order to reduce corrosion, it is necessary to:

- Avoid the use unsuitable metals in an aggressive environment.
- Avoid contacts between dissimilar metals which different galvanic couples.
- Use conductors of appropriate gauges and corrosion-resisting fasteners.
- Provide protective coatings in critical cases as appropriate to the external influences.

To meet the above requirements, the following precautions are given as typical examples:

- The minimum thickness or diameter of a conductive item should comply with standard mentioned in this specification.

- Copper/aluminium joints should be avoided wherever possible. If unavoidable, joints should be made using suitable two-metal connections.
- Copper is usually suitable for earthing, except under certain acid conditions, when exposed to oxygen or sulfate.
- When there are sulfuric or ammoniacal fumes, a coating may be used on the down-conductors.
- Conductor fasteners should be made of stainless steel or suitable synthetic material under corrosive environmental conditions.

6 Special Measures

An antenna on the roof of the premises increases the lightning stroke probability and is the first vulnerable item likely to receive the lightning discharge.

When this is an individual or collective radio broadcasting receiver antenna, complying with the standard, the antenna support mast should be connected through a surge protective device or a spark gap to the down-conductors of the installation by a standard conductor unless the antenna is outside the protected area.

A common support mast can be used under the following conditions:

- The common support mast consists of adequately strong tubes, which do not need guy lines.
- The air terminal is attached to the tip of the mast.
- The air terminal tip is at least 2m above the nearest antenna.
- The down-conductor is attached by a clamp which is fastened directly onto the rod.
- The antenna coaxial cable routed inside the mast antenna.
- It is preferable to route the coaxial cable through a metal tube.

7 Inspection & Maintenance

LPS maintenance is essential since a number of components may lose their effectiveness over time due to corrosion, weather, mechanical impacts, and lightning. The mechanical and electrical characteristics of an LPS should be maintained throughout the LPS life in order to meet the standard requirements.

7.1 Initial Inspection

Once the air terminal installation is completed, it should be inspected to make sure that it complies with the provisions of this standard.

The purpose of this inspection is to make sure that:

- The air terminal head is 4 meters or more above the entire protected area.
- The materials and the gauges used for the down-conductors are suitable.
- Sizes of down-conductors, head, earthing rod are according to standards.
- The down-conductors are routed, located and electrically bonded as required.
- All the installation components are firmly secured.
- The safety distance is respected and/or equipotential bonding are provided.

- The earth termination system resistance values are correct.
- The earth termination systems are interconnected.
- This inspection should be performed visually under the conditions stated in standards NF C 15-100, and NFC 17-102.

However, where a conductor is entirely or totally hidden, its electrical continuity should be tested. Such a test should conform to part 6 of standard NF C 15-100.

7.2 Inspection Procedure

A visual inspection should be performed to make sure that:

- No extension or modification of the protected structure calls for the installation of additional lightning protective measures.
- The electrical continuity of visible conductors is correct.
- All component fasteners and mechanical protectors are in good condition.
- The safety distance is respected and there are enough equipotential bonding and their condition is correct.
- Conductors size & installation.
- Air terminal type & installation.

Measurements should be taken to verify:

- The electrical continuity of hidden conductors.
- The earth termination system resistance values

END OF SECTION

SECTION 16740

TELEPHONE SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Specification sections, apply to this Section.

B. Division-16 Basic Electrical Requirements sections apply to work specified in this section.

1.2 SUMMARY

A. Telephone system work is indicated by drawings and schedules, and is hereby defined to include, but not be limited to telephone wiring/cabling, private branch exchange, conducting and proper connection to local city telephone network.

2. PRODUCTS

2.1 EPABX

A. PBAX to be electronic type fully IP supporting IP, Digital & analogue extensions, with 6 exterior lines & 24 interior lines, expandable type.

i- Type:
PABX must be compatible with the relevant public exchange equipment as existing. It shall be electronically exchanged, fully digital and stored program controlled. It shall facilitate an integrated voice/data system that is capable of transmitting voice and data simultaneously. PABX is to be designed for use as a standard telephonic exchange for all applications. It shall be possible to connect any combination of standard serial-pulse and DTMF telephones to the PABX, with manufacturer-made interface modules as necessary within the exchange and without the need to modify the assembly. All control functions shall be performed by latest technology of micro and mini processors. Full duplications should be provided for all control and service cards. PABX shall be provided with all needed analog licenses, IP, analog & digital ports, PRI media, music on hold, all needed gateways, full redundancy, auto attendant, hospitality messaging solution, and voice mail system. The IP telephony infrastructure shall be designed to sustain all kinds of security and virus attacks and support encryption of voice streams without impairing the connection or voice quality.

The Unified Communications (UC) component must provide a single identity & presence enabled communications and collaboration solution. The UC component should deliver rich communications across multiple media (telephony, email, voice-mail, IM, video & web conferencing), which are intuitive and accessible from anywhere on any device, integrated into business process and can be efficiently and securely deployed into existing customer environment.

The IP telephony & UC components must be tightly integrated to ensure it is possible to make and receive remote calls to/from any analogue, digital or IP phone and the public voice network, to provide remote call control between the desk phone and PC client and to provide telephone presence.

The system must support the following features without the need for any additional hardware:

- Account codes
- Administered connections
- Answer detection
- Authorization codes
- Automated attendant (full option)
- Automatic call distribution
- Automatic alternate routing
- Automatic camp-on
- Automatic circuit assurance
- Automatic number id
- Automatic recall
- Automatic route selection-basic
- Automatic transmission measurement system
- Call by call service selection
- Call detail recording
- Call log
- Centralized attendant service
- Classes of restriction
- Classes of service
- Code calling access
- Controlled private calls
- Delayed ringing
- Dial plan
- Dialed number id service
- Direct department calling
- Direct inward dialing
- Did call waiting
- Direct inward termination
- Direct outward dialing
- Extended trunk access
- Facility restriction levels
- Facility test calls
- Forced entry account codes
- Hunting
- Integrated system directory
- Least cost routing
- Modem pooling
- Multiple listed directory numbers
- Music on hold
- Night service (fixed & programmable)
- Off-hook alarm
- Off premises station
- Open system speed dial
- Password aging

- Power failure transfer station
- Recent change history
- Restriction features
- Fully restricted
- Miscellaneous trunk
- Toll/code
- Trunk
- Voice terminal
- Route advance
- Security violation notification
- Shared tenant service
- System speed dial
- System status report
- Time of day routing
- Timed reminder
- Trunk answer any station
- Trunk callback queuing
- Uniform call distribution
- Uniform dial plan
- Virtual extension
- Voice message system interface
- The system must support full attendancy features
- Call waiting
- Conference
- Display
- Intrusion
- Paging/code call access
- Priority queue
- Recall
- Operator at PABX can see that an office does not want to receive calls (Maximum privacy)
- Call converge
- Call forward busy
- Call forward busy inside
- Call forward programmable
- Call park
- Call pickup
- Call privacy
- Callback/ring again
- Caller ID
- Directories
- Do not disturb
- DTMF delivery
- Features access codes
- Intercom capability
- Visual message waiting indication
- Digital & analogue telephones must require single pair copper cables.
- Automatic server fail-over
- Provide all reports needed as per client’s requirements

ii- Cabinet(s):
Exchange components are to be grouped in a modular, totally enclosed, sheet metal cabinet, corrosion resistant, with lockable front accessories, and the whole assembly is to fit into one integrated form. Cabinet(s) is to be dust and insect proof, and ventilation is to be provided as required for specified ambient conditions as well as air-conditioning facilities. All internal metal surfaces of the cabinet shall be protected against corrosion. All external metal surfaces shall be treated, prior to finishing, with metal spray galvanizing, plating, then primed treated to provide a first class base for epoxy point finish.

iii- Plug-in Equipment:
Electronic circuits and components, which are all solid state components, are to be plug-in card type. Equipment are to be assembled neatly in racks. Sensitive components are to have dust-protection covers.

Manufacturer: Alcatel, Siemens, Ericsson, Avaya or approved equal

2.2 CONNECTION MODULES

A. IDC (Insulation Displacement Contact) Modules will comprise the terminal blocks in the MDF and distribution frames (if needed). They will be of high reliability, and will have the following minimum specifications:

MDF size	or as shown on drawings	
conductor diameter	0.4 to 0.8	mm
insulation diameter	0.7 to 1.5	mm
number of insertions	1000	times
maximum contact resistance	0.02	ohm
dielectric strength (60 Hz)	2000	V (r.m.s.)
minimum insulation resistance	10000 Mega-ohm, at 500 V (dc)	

2.2 DISTRIBUTION COMPONENTS

B. Distribution Cabinets: distribution cabinets & MDF if needed to be of high professional quality, metal type, dust proof, IP42 minimum, corrosion resistant, wall mounted by screws, with tamper proof removable screw covers, cable holder rings, labelling plates, equipped with relevant connecting strips, and have efficient capacities to fully wire the complete incoming cable and outgoing ones.

C. Connecting Strips will have thermoplastic bodies, nickel plated brass connectors, galvanized screw terminals in both sides, wire guides, and will have the following electrical specifications:

rang of conductor diameter	up to 1.2mm
dielectric Strength (50 Hz)	1500v (r.m.s.)
minimum insulation resistance	10000 Mega-ohm, at 500 V (dc)

D. CONDUITS AND RACEWAY are to be provided in accordance with the relevant Section of the Specification, and as shown on the drawing and in full compliance to PTT requirements.

2.3 CABLES AND OTHER ACCESSORIES

A. Telephone Cables: will be CAT 6, UTP as per EIA/TIA.

B. Telephone Cables will be Classified: according to their location in the network into two types: riser cables (main cables), and distribution cables. Riser cables will be outgoing from, and incoming to, the MDF; whereas distribution cables will include the cables outgoing from distribution frames (cabinets) to distribution boxes as well as those outgoing to telephone outlets whatsoever Belden, IBM, Alcatel or equal.

C. Raceways: will include all conduits, cable trunking, and cable trays. Comply with the relevant sections of the Specifications.

D. Fixing, Labeling, and Marking Accessories: fixing accessories will include cable ties, clamp ties, push mounted ties, marker ties. Labels and markers will be made of white plastic or polyester, durable type, subject to the approval of the engineer. Each label will indicate, according to an approved labeling designations, the cable-number, and the two distribution units where the cable is coming from and going to.

E. Raceways: telephone cables are to run in dedicated raceways segregated from those where power cables are laid. Moreover, telephone cables will not share undivided trays or paths with any other type of cables. The installation, and fixation will be as per the relevant section of the specification, field and installation work, unless otherwise is indicated herein.

F. Cable Laying: before the start of cable works, the site will be properly checked in order to ensure that the raceways, whatsoever, are clean and dry. Cables will be carefully unreeled from drums, and pulled-in/laid-on raceways according to the approved shop drawings and work procedure. Specialized rolls and tools will be used for cable works so as the cables will not be dragged on ground or surfaces. Cables are to run concealed above cable trays, and through embedded pipes. Under false floors; if any, they may be arranged above ground, subject to the approval of the engineer. All pipe ends, whether occupied or empty, will be perfectly sealed against dirt, parasites, rates, and insects. Sealing material, or elements will be according to every specific site condition, subject to the approval of the Engineer. After the network is satisfactorily completed and tested, cables will be tied to cable trays and labelled as necessary. For any cable, the maximum distance between two successive ties will not exceed five meters except for vertical riser cables where the maximum distance will be two meters. Cables will be labelled at every terminal location, every bent, before every distribution unit, and at every fan-out. Moreover, vertical main cables, along the riser, will be labelled at lease twice in each floor.

G. Cable Wiring: cables will be terminated at the distribution units where they will be held, fanned out properly, and wired to the terminal blocks or connecting strips. Wires will be tied into groups, in accordance with the order of pairs as per color code, and corresponding to the relevant connection modules (or strips). Wiring to the terminal blocks in MDF and distribution frames (cabinets) will be performed by standard IDC connection tools, no soldering will be needed, whereas the wiring of distribution cables to the terminal strips in distribution boxes may be completed by screw drivers.

H. Jumper Wires: are to extend neatly between connection modules, moderately stretched, and guided by the specialized rings and hooks. No jumper will be left loose or imperfectly guided. The final arrangement of jumper wires within any cubicle will allow for an easy trace of any telephone line.

I. Earthing: every cable, distribution unit, and equipment will be properly earthed as necessary and as recommended by manufacturers. Earthing system will ensure safety conditions and will eliminate noise effects. Earthing cables will be characterized by their green/yellow color. Provide interference-free earthing as necessary.

J. Wireless Access Points (WAP) shall be of a modular design, enclosed in a housing listed for use in environmental return air spaces, permitting a dual radio configuration, with complete backward compatibility for legacy clients. WAP shall support IEEE 802.11b/g standards & 802.11a. WAPs shall support 5 dBi Omni-directional and 9 dBi directional patch antenna at a minimum. The WAPs should obtain power over the Ethernet (POE). All switches used shall be capable of providing POE for the corresponding WAPs.

3.2 **ON-SITE TESTS, AND INSPECTION**:

A. Test Plans: all tests will be carried out according to a detailed test procedures which is submitted by the contractor and approved by the engineer. The tests will cover every aspect related to the specification of the material and their operation; including, but not limited to, visual inspections, insulation tests, measurements, and operation. All instruments to be used during the tests must have been calibrated and certified, by an authorized official laboratory, as complying with the specification of their manufacturers.

B. On-Site Cable Tests: cables are to be tested to ensure that no damage have occurred to them during transportation to site and/or during the course of pulling-in and laying. A complete wire-to-wire continuity test is to be performed for every cable length. The contractor will have to replace any length where the electrical continuity is not verified for all wires. Then, a 10% sample of all cable lengths will be subject to an insulation test, according to the manufacturer specifications. Sampling will be random and as decided by the engineer. The contractor will have to replace a cable should its insulation resistance is below the minimum specified.

C. On-Site System Tests: equipment will be tested to ensure that they are not damaged by transportation, correctly assembled and connected, properly powered, and operating as specified. The complete system tests will include the following minimum checks:

- Visual inspection of every component (including painting assembly, labeling, etc.)
- Dielectric strength and insulation resistances.
- System performance (including all operation features).
- Any other checks as necessary to ensure full compliance with the technical specifications.

  It will be demonstrated to the satisfaction of the engineer, that the installed equipment meet the requirements of the specification and is ready for taking-over.

A. Experimental Period: after the on-site tests are satisfactorily completed in accordance with the technical specifications and approved procedures, and before final acceptance which is leading to provisional taking over; the contractor will assume a one-month experimental period during which the system performance will by fully demonstrated under actual operation conditions. This demonstration is to confirm, to the satisfaction of the engineer, that the system is free of remarks and is ready for provisional taking over.

3.3 DESIGN PARAMETERS:

A. The telecommunication's service entrance and installation shall meet the requirements of the public service telephone network PSTN.

B. Voice/data installations are to comply with the requirements of PSTN and the relevant CCITT recommendations and the electronic industries association/telecommunication industry association standard EIA/TIA-568 and commercial building telecommunication wiring standard.

C. The communications wiring shall be installed to the requirements of the IEE and the manufacturer's recommendations.

3.4 ADJUSTING AND CLEANING:

A. Clean telephone equipment and components of dirt and construction debris upon completion of installation including conduits inside each room, telephone pull boxes, cable tray in shaft, MDC, PBX and conduits leading to local city network.

B. Touch-up scratched or marred enclosure surfaces to match original finishes.

C. Protect installed equipment and components from damage during remainder of construction period.

END OF SECTION

SECTION 16740A

DATA SYSTEM

PART 1 GENERAL

1.01 DESCRIPTION

A. Provide a complete, tested, cable distribution, & data equipment for data system (local area network. The data distribution system shall include fully terminated UTP backbone as well as UTP station cables. Switches and data cabinets to be supplied, installed and connected by IT specialist contractor including all needed switches, routers, patch panels, RJ45 outlets, cat6 cables, conduits, cable trays & cable organisers .

B. One Main Data Cabinet (MDC) to be installed, where all data & telephone points are terminated.

C. Provide system design services (development of specific details consistent with the contract documents) as required to complete shop drawings for data cables & data cabinets detail including detailed documentation for client's review and detailed documentation of as-built conditions.

D. The Contractor shall coordinate with other system vendors where appropriate to facilitate equipment installation, scheduling, protection of equipment, and access to the project site in order to provide the owner a substantially complete project in a timely manner.

E. The successful communications Contractor shall attend a mandatory pre-construction meeting with individuals deemed necessary by the owner prior to the start of work.

F. The successful bidder will not be determined by price alone, but by a rating system to include a combination of price, qualifications, training procedures, and proposed documentation package.

1.02 CONTRACTOR'S RESPONSIBILITIES

A. The Contractor shall furnish all data equipment and materials whether specifically mentioned herein or not, to ensure a complete operating system. The Contractor shall make sure that electric Sub-Contractor of first fix and raceway works has provided all conduits, junction boxes, and cable trays where specified for telecommunications cabling and shall bring forward all necessary deviations or new raceway requirements.

B. The Contractor shall generate all shop drawings and information for the complete installation and wiring of the system. The Contractor shall provide (or sub-contract for) the on-site installation and wiring, and shall provide ongoing supervision and coordination during the implementation phase.

C. The Contractor shall be responsible for the initial adjustment of the systems as herein prescribed and shall provide all test equipment for the system checkout and acceptance tests.

D. The Contractor shall provide on-the-job training in the operation and maintenance of the system for personnel designated by the Employer.

1.03 QUALITY ASSURANCE

A. All equipment provided by the Contractor shall be new and shall meet or exceed the latest published specifications of the manufacturer in all respects.

B. Contractor to provide the latest model/revision of a specified piece of equipment, at the time of bid.

1.04 DELIVERY, STORAGE AND HANDLING

A. Costs of all shipping to the site, and of all unusual storage requirements, shall be borne by the Contractor. It shall be the responsibility of the Contractor to make appropriate arrangements, and to coordinate with authorized personnel at the site, for the proper acceptance, handling, protection, and storage of equipment so delivered.

B. Movement of material either at the time of delivery or subsequently shall be the sole responsibility of the Contractor. All costs associated with this movement shall also be the responsibility of the Contractor.

1.05 PROJECT CONDITIONS

A. Contractor responsible for keeping schedule regardless of local disputes.

B. Contractor responsible for protection of his work from acts of vandalism and environmental conditions.

C. Contractor to clean up and repair all areas affected by his installation.

1.06 SEQUENCING AND SCHEDULING

A. Provide your own schedule listing your activities including manpower allocation and material procurement that demonstrates how you plan to meet the construction schedule. This schedule should include manpower and duration required for each phase.

1.07 WARRANTY

A. Warranty systems in writing against defects in material and workmanship for 1 year after system acceptance. During this time the system shall be kept in proper operating order at no additional labor or material cost to the Employer.

B. Service must be rendered within 24 hours of notification.

C. Visit site once a month during warranty period for checking and adjustment.

D. Actions which may void guarantees or other contracts on equipment are to be submitted for approval prior to being undertaken. Contractor not responsible for guarantees for materials or work and/or existing contracts if above action is approved.

E. Contractor assumes responsibility for quality and satisfactory operation of components and materials not manufactured by Contractor, submit guarantee endorsed by manufacturer of materials.

F. Whenever a guarantee of durability, operating capacity or proper functioning are noted, manufacturer shall furnish detailed drawings, test certificates.

1.08 SHOP DRAWINGS

A. Floor plans: Furnish floor plans for approval based on owner's final requirement showing exact outlet locations with an indication of outlet type and proposed label. Floor plans shall be coordinated with architectural and electrical power plans and shall be produced at the same scale as the electrical power plans. Schematic diagrams & elevations shall be submitted for each data cabinet detailing its ful content.

B. Terminal elevations: Furnish details showing terminal block and backboard elevations including all cable terminals, spaces for equipment, equipment racks, and station cable routing. Communications equipment closets shall be arranged to maximize the utility and growth potential available in spaces shown on the floor plans. Terminal elevations shall be based on detail elevations included in the contract documents and shall show additional detail as indicated herein.

C. Outlet locations: Provide as shown.

D. Terminal schedules: Furnish terminal schedules showing terminal block positions for all station cabling. Terminal outlet schedules shall show proposed labels for all four-pair UTP horizontal cables at station outlets along with patch panel locations.

1.09 SUBMITTALS

A. Project initiation: Contractor shall furnish the following in a single consolidated submittal:

1. The name of the person who will act as the low voltage Contractor's official contact with the Contractor/owner/engineer.

2. Electrical permits: The Contractor shall obtain all required permits and provide copies to the owner/engineer.

3. Complete manufacturer's product literature for all cables, patch panels, cable supports, cable labels, outlet devices, racks, switches, routers and other products to be used in the installation. In addition, whenever substitutions for recommended products are made, samples (when requested by the owner/engineer) and the manufacturer's supporting documentation demonstrating compatibility with other related products shall be included.

4. A time-scaled construction schedule, indicating general project deadlines and specific dates relating to the installation of the cable distribution system. At a minimum, this construction schedule shall include the following milestones:

   - Start of communications space construction
   - Start of fiber optic cable terminations
   - Start of Category 6 (telephone), Category 6 (data) UTP (including related termination hardware)
   - Data cabinets
   - Start of Category 6 (telephone), Category 6 (data) UTP cable testing
   - Final inspection

5. Shop drawings

6. Proposed Contractor Category 6 (telephone), Category 6 (data) UTP cable test result forms.

B. Project completion: As a condition for project acceptance, the Contractor shall submit the following for review and approval.

1. Complete manufacturer's product literature and samples for all pre-approved substitutions for the recommended products made during the course of the project.

2. An exception list of deviations (in materials, construction, and workmanship) from that specified in this section and shown on the project drawings. The owner will review this list and declare each item as either an approved exception or as one the Contractor must correct.

3. Inspection and test reports: During the course of the project the Contractor shall maintain an adequate inspection system and shall perform such inspections to ensure that the materials supplied and the work performed conform to contract requirements. The Contractor shall provide written documentation indicating that materials acceptance testing was conducted as outlined in Part 3 below. The Contractor shall also provide documentation indicating that all cable termination & data cabinets testing procedure were completed and that all irregularities were corrected prior to job completion for owner/engineer analysis.

1.10 AS-BUILT DRAWINGS

1. Prior to contract close-out, submit one copy of the system As-Built drawings and documents to the Engineer for review. Submit two copies to the owner.

1.11 TEST RESULTS

Prior to systems acceptance and commissioning, submit system testing documentation showing methods and results for all tests performed.

Provide written certification by the Contractor that all active & passive equipment have been properly installed and tested as per the Specifications and Manufacturer's instructions. This written certification shall be signed by the executive officer of the contracting organization and submitted for approval.

1.12 SYSTEM INSTALLER

A. The data system installer shall be a certified firm normally employed in the low voltage cabling industry with a reference list of five (5) projects and contact names to confirm successful Category 6 (telephone), Category 6 (data) UTP cables plant projects.

B. The owner reserves the right to exercise its discretion to require the Contractor to remove from the project any such employee of the Contractor deemed by the owner to be incompetent, careless, insubordinate, or otherwise objectionable.

C. The selected system installer should be factory certified for the products it installs and be able to provide a factory warranty of no less than 10 years covering both product and performance of materials installed. Quality and workmanship evaluation shall be solely by the owner/engineer and designated representatives.

1.13 REGULATORY REQUIREMENTS

A. All work shall be performed in accordance with the latest revisions of the following standards and codes:

Uniform International Conference of Building Officials (ICBO).
Local Building Code of Lebanon
BS Code

B. Other References:

EIA/TIA-568 Commercial Building Wiring Standard

EIA/TIA-569 Commercial Building Standard for Telecommunication Pathways and Spaces

EIA/TIA TSB36 Additional Cable Specifications for Unshielded Twisted Pair Cables

EIA/TIA TSB40 Additional Transmission Specifications for Unshielded Twisted Pair Connecting Hardware

EIA/TIA 455-A Standard Test Procedure for Fiber Optic Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components.

1.14 ABBREVIATIONS

DC Direct current.

MDC Main distribution cabinet

UTP Unshielded twisted pair (telecommunications station cable)

SW,Switch/Hub

PART 2 PRODUCTS

2.01 GENERAL WIRING

A. The wiring plan shall be installed per requirements of these specifications utilizing materials meeting all applicable EIA/TIA standards. Cables shall be capable of high speed data transmission.

The following cables shall be used:

Fiber (multi mode) for vertical backbone data riser.
Cat 6 UTP for telephone and data wiring.

B. Materials shall be as UL listed or shall be equivalent products of other manufacturers meeting the intent and quality level of the EIA/TIA TSB36 and TSB40 specifications. All approved equivalent products will be published by addendum prior to bid.

C. All installed wire shall be tested "100 percent good" after installation by the installer.

D. All products shall be new and brought to the job site in original manufacturer's packaging. Electrical components shall bear the Underwriters Laboratories label. All communications cable shall bear flammability testing ratings as follows:

CM Communications cable

CMP Plenum-rated communications cable

CMR Riser-rated communications cable

E. Initial cable inspection: The Contractor shall inspect all cable prior to installation to verify that it is identified properly on the reel identification label, that it is of proper gauge, containing the correct number of pairs, etc. Note any buckling of the jacket that would

indicate possible problems. Damaged cable or any other components failing to meet specifications shall not be used in the installation.

2.02 STATION WIRING

A. The horizontal wire provided for all outlets shall be one four-pair UTP, Category 6 (telephone), Category 6 (data) cable per jack:

1. Duplex data outlet shall have two data cables each with its own jack.

B. The Category 6 (telephone), Category 6 (data) four-pair UTP cable must be UL Performance Level tested. Each 1,000-foot spool must be individually tested with test results affixed to the spool.

Recommended Products: 3M, Leveton, Tyco & Systimax or pre-approved equivalent.

2.03 STATION HARDWARE

A. Flush-mounted jacks shall be high-quality Category 6 (telephone), Category 6 (data) RJ45 modular jacks with circuit board construction and IDC-style or 110-style wire, T568A terminations. Jacks shall meet EIA/TIA TSB40 recommendations for Category 6 connecting hardware.

B. Faceplates shall match manufacturer for RJ45 outlets at all locations.

C. Surface mount jacks shall be high-quality RJ45 modular jacks per A above.

2.04 DATA TERMINATION HARDWARE

A. Data Category 6 (voice), Category 6 (data) termination hardware: The Category 6 (telephone), Category 6 (data) data station cable shall be terminated on Category 6 (telephone), Category 6 (data) RJ45 patch panels with circuit board construction. The RJ45 patch panels shall be either wall mounted or rack mounted. The Contractor is responsible for all wall brackets, patch panels, for all DCs equipment as shown on drawings and to the approval to university representative.

The panel cover shall permit masking of parts not in use. A cable safety feature shall be provided by a retaining system. Color-coded port identification shall be provided.

B. Wall brackets must be provided for all patch panels for wall mount applications.

Approved products: 3M, Leviton, Tyco, & Systimax or pre-approved equivalent.

2.05 DATA DISTRIBUTION EQUIPMENT RACK

A. Provide equipment racks in locations indicated on the drawings. Racks shall be equipped as detailed on the drawings and as hereafter specified and to university representative approval.

2.06 FIBER OPTIC CABLE SPECIFICATIONS

A. Fiber optic cable shall be UL-listed type OFNP; six core, multimode fibers, each with a color-coded PVC buffer. Maximum attenuation shall be 3.75 dB/km at 850 nm and 1.0 dB/km at 1,300 nm. Minimum bandwidth shall be 160 MHz/km at 850 nm and 500 MHz/km at 1,300 nm and contain no metallic elements.

2.07 FIBER OPTIC CABLE TERMINATIONS

A. Optical fiber connectors shall be ST or LC connectors.

Approved products: 3M, Leviton, Tyco, & Systimax or pre-approved equivalent.

B. Optical fiber termination enclosure: The enclosure used in the computer room shall provide termination panels of sufficient size and capacity to terminate 100 percent of the fiber count of the inside or outside fiber optic cables. Patch panels must be wall or floor mounted & sized as shown on drawings minimum. Provide all termination accessories and enclosures and test for a complete fiber optic distribution system.

2.08 FIBER OPTIC PATCH PANEL (if needed)

a. All fiber optical cables must be terminated on patch panels from which they are connected to the required devices.
b. Fibre optic patch panels shall comply with transmission requirements of cat6 cabling system standards and must be mounted on 19” rack

2.09 FIBER OPTIC NETWORK (BACKBONE)

A. Backbone fibre optic cable shall follow TIA/EIA standards for fibre optic installation and certification.

B. The maximum distances for multi mode fibre for 100Mbit/s Fast Ethernet connection is 2000 meters, or with single mode fibre about 3000meters.

A. Backbone fibre connections running on a 1000 Mbit/s Giga Ethernet can cover a maximum distance of 525 meters on a 50/125 micron multi mode cable (only 260 meters for 62.5/125 micron multi mode fibre optic cabling.
B. The backbone cabling for Giga Ethernet should consist of 50/125 micron multi mode fibre optic cabling or of single mode fibre optic if longer distances must be covered.
C. The fibre optic cabling shall be configured in a star topology originating from the MDC as shown on drawings.
D. Avoid installing in areas where sources of high levels of EMI/RFI may exist. Specific distances are provided in ANSI/TIA/EIA.
E. Bridge taps are not allowed for structured cabling.
F. Grounding should meet requirements of EIA/TIA 607.
G. Fibre optic cables for vertical system shall be indoor cables, multi-mode of the 62.5/125micron multi type. Its features are, but not limited to the following:
    a. Central core design with 8 fibre
    b. Rodent-protection and strength member combined.
    c. Increased crush resistance
    d. Halogen free, flame retardant sheath (FR/LSOH)
    e. Temperature range from -10 to 50 deg Cent

2.10 DATA RACKS

A. Switches enclosures shall lockable with cooling fan built-in to provide circulation.

B. Data racks containing network components and patching panels shall be capable of having the front doors shut and locked without introducing any strain or pressure on any part of the equipment or cables installed within the racks.
C. Data cabling racks, shall comprise:
D. Standard 19” practice
E. Removable front sides and rear panels.
F. Safety glass front door with lock and removable keys.
G. Full width fan trays
H. Multi way power strip
I. Cable management trays inside racks.
J. Earth straps for all doors, sides, and panels.
K. Earth bonding to building safety earth
L. Earth cables must be provided to all metallic doors on data racks. Earth connections must be provided to all patch panels from the data racks earthing point.
M. All equipment shall be installed in cabinets either on shelves or on rack mounting brackets.
N. Each cabinet shall be provide with a documentation wallet.
O. All equipment must be installed with the interface connectors to the front.

2.11 DATA PATCH PANELS

A. Patch panels shall be designed to enable the connection of either voice or data services to the horizontal data cabling.
B. Patch panels in wiring closets shall be interconnected using four pair cat6 data cables as a minimum, or optical fibres between adjacent closets.
C. Patch panels shall be based on RJ-45 presentation, using IDC connections.
D. Sufficient space must be allowed at the patch panel for labeling of all ports and patch cord wire guides.
E. Patch panels shall be installed such that the connector pins are aligned uppermost and the retaining key on the bottom of the outlet.
F. All patch panels shall include sufficient rear space for termination and marshalling of cables
G. All patch leads, user leads, connection leads and main cable runs for each cabling system shall be of the same cable specification and from the same batch of cables.

Approved products: 3M, Leviton, Tyco, & Systimax or pre-approved equivalent.

2.12 LAN & SWITCH DESIGN

A. Local area networks should be configured to ensure maximum resilience and continued operation failure of any single component. A redundant switch must be used when routing voice over IP or other IP enables audio/video devices in the network.
B. The approved configuration is a pair of Ethernet switches, to which all servers and network services are attached and from which clients are attached directly or via switches.
C. The routing information protocol (RIP) is designed for exchanging routing information.
D. Switches must be configured and installed by a professional network specialist.
E. Switches must support POE, QOS & VLANS.

F. Typical features for switches: chassis system unit, redundant power supplies, high Ethernet port density, configurability, manageable and remote access, spanning tree protocol, VOIP support

G. Switches to be available in two classes:

1- High-End Switches, offering high performance, increased expansion, extremely high fault tolerance, and high availability capabilities and highly resilient. High end switches are used inside computer rooms. Switches to be 10 Gigabit Ethernet support, layer 4-7 switching, & security features.

2- Mid-End Switches, typically on floor level, providing high number of possible VLANS, supporting POE, with 10/100/1000 Mbit/s port and flexible uplink ports, with layer 3 switching.

Approved products: SISCO or approved equal.

PART 3 EXECUTION

3.01 GENERAL

A. The Contractor shall avoid penetration of fire-rated walls. Sleeving shall be installed for access where necessary.

B. Any penetration through fire-rated walls (including those in sleeves) will be resealed with an Underwriters Laboratories-approved (UL) sealant. Typical of this type of product is Flame seal. Contractor shall also seal all floor, ceiling, and wall penetrations in fire or smoke barriers and wiring closets.

C. Allowable cable bend radius and pull tension: In general, communications cable cannot tolerate sharp bends or excessive pull tension during installation. Refer to the cable manufacturer's allowable bend radius and pull tension data for the maximum allowable limits.

D. Cable lubricants: Lubricants specifically designed for installing communications cable may used to reduce pulling tension as necessary when pulling cable into conduit. After installation, exposed cable and other surfaces must be cleaned free of lubricant residue.

E. Pull strings: Provide pull strings in all new conduits, including all conduits with cable installed as part of this contract.

F. The Contractor shall replace any damaged ceiling tiles that are broken during cable installation.

G. The Contractor shall replace or rework cables showing evidence of improper handling including stretches, kinks, short radius bends, over-tightened bindings, loosely twisted and over-twisted pairs at terminals, and cable sheath removed too far (over 3.5cm).

3.02 LABELS

A. The labeling plan shall be developed by the Contractor. The Contractor will label all outlets following the detailed shop drawing design, using permanent/legibly typed or machine-

engraved labels approved by the owner. The labeling information for data cabinets will include the switch number and patch panel number. Outlets shall be labeled to match the corresponding label in the patch panel all copper/fiber terminations for riser/backbone cables shall be labeled with the patch panel number.

B. A floor plan clearly labeled with all outlet jack numbers shall be included in the as-built drawings.

C. All labels shall correspond to as-builts and to final test reports.

DATA SYSTEM (16740A) (CONT'D)

3.03 TECHNICAL SPECIFICATIONS RJ45 CAT 6

ELECTRICAL DATA

Insulation Resistance	≥ 500 Mohm	(IEC 512-2-2a)
Dielectric Strength	Contact/ contact	1.0 KV
	Contact/ shielding	1.5 KV

TERMINATIONS

Typical termination resistance	≤ 20 Mohm	(EN 60603-7)
Current carrying capacity (DIN EN 60603-7)	≥ 1 A	(EN 60905)
Insertion cycles	≥ 750	(IEC 512-2-13b)

MECHANICAL DATA

Shield connection	patented 360° Shielding	
Conductor diameter	0.5-0.6 mm (AWG 22-24)	
Insulation diameter	1.05-1.06 mm	
Re-terminations of of LSA-PLUS contacts	≥ 200	
insertion/ pullout force	20 N	(EN 60603-7)

3.04 STATION WIRING INSTALLATION

A. The low voltage Contractor shall supervise the installation of communications cable. All Category 6 and fiber optic cables shall be installed by individuals trained in voice and data cable system installations. All Category 6 (telephone), Category 6 (data) four-pair UTP cable must be handled with care during installation so as not to change performance specifications. The Contractor shall not over-tighten tie wraps or over-bend the Category 6 (telephone), Category 6 (voice and data) four-pair UTP cable.

B. Exposed station cable will only be run with owner approval. Approval will be granted only when no other option exists. When station cable must be run surface to a single outlet, surface raceway shall be used to cover the cable.

C. All cabling and associated hardware shall be placed so as to make efficient use of available space in coordination with other uses. All cabling and associated hardware shall be placed so as not to impair the owner's efficient use of their full capacity.

D. Attaching cable to pipes or other mechanical items is not permitted. Communications cable shall be routed to avoid light fixtures (45cm minimum spacing), sources of heat (30cm minimum spacing), power feeder conduits (30cm minimum spacing).

DATA SYSTEM (16740A) (CONT'D)

3.05 STATION HARDWARE

A. Surface mount jacks (where permitted) shall be securely attached to walls or permanent furnishing and will not be attached to the floor under any circumstances. Use of adhesive tape for this purpose will not be allowed.

B. Flush-mounted jacks shall be mounted in a faceplate with back box.

C. RJ45 jack pin assignments:

1. Pin connections for both telephone, data station cable outlets, and patch panels shall match EIA/TIA-568 modular jack wiring recommendation T568A, which is both 10BaseT and ISDN compatible.

2. Pin connections at data jack panels shall match pin connections at outlets—straight through wiring.

3.06 BACKBOARD CABLING/EQUIPMENT RACK CONFIGURATION

A. All cabling shall be routed so as to avoid interference with any other service or system, operation, or maintenance purposes such as access boxes, switches or electrical outlets, electrical panels, and lighting fixtures. Avoid crossing areas horizontally just above or below any riser conduit. Lay and dress cables to allow other cables to enter the conduit/riser without difficulty at a later time by maintaining a working distance from these openings.

B. Cable shall be routed as close as possible to the ceiling, floor, or other corners to ensure that adequate wall or backboard space is available to current and future equipment and for cable terminations. Cables shall not be tie-wrapped to existing electrical conduit or other equipment. The minimum bend radius shall be observed.

C. Lay cables via the shortest route directly to the nearest edge of the backboard from the mounted equipment or block. Lace or tie-clamp all similarly routed cables together and attach by means of clamps screwed to the outside edge(s) of the backboard vertically and/or horizontally, then route via "square" corners over a path that will offer minimum obstruction to future installations of equipment, backboards, or other cables.

D. Provide rack and jack panel hardware as required for all data station wiring.

E. Do not over-tighten cable ties or binding on Category 6 station cable. Observe Category 6 cable bend radius.

DATA SYSTEM (16740A) (CONT'D)

3.07 TWISTED PAIR CABLE TESTING (CONT'D)

A. Acceptance of the simple test procedures discussed below is predicated on the Contractor's use of the recommended products (including but not limited to twisted pair cable, cross-connect blocks, and outlet devices specified in the products paragraph) and adherence to the inspection requirements and practices set forth. Acceptance of the completed installation will be evaluated in the context of each of these factors.

B. At a minimum, the Contractor shall test all station drop cable pairs from termination patch panels to outlet device, RJ45 jacks.

C. Each wire/pair shall be tested at both ends for the following:

1. termination order
2. polarity (pair reversals)
3. continuity
4. shorts
5. grounds
6. attenuation
7. near end cross talk
8. cable length (record all lengths)

D. When errors are found, the source of each error shall be determined and corrected and the cable retested. All defective components shall be replaced and retested. Defective components not corrected shall be reported to the owner/engineer with explanations of the corrective actions attempted.

E. Test records shall be maintained using a form approved by the owner. The form shall record closet number, riser pair number or outlet ID, outcome of test, indication of errors found (i.e., a, b, c, d, e, f, or g), cable length, retest results after problem resolution, and signature of the technician completing the tests.

F. Test results for each Category 6 four-pair UTP cable must be submitted with identification to match labels on all patch panel ports and RJ45 jacks and must match as-builts associated with that cable.

3.8 SOURCE QUALITY CONTROL

A. **Manufacturer's Test**

1. All cables, components, and equipment shall be factory tested for continuity and all functions before shipment. Submit documentation to Engineer where items have been tested by the manufacturer to applicable Industry Standards.

B. **Inspection**

1. Submit certified data to Engineer confirming that all products and materials furnished have been manufactured and connected under strict quality assurance.

C. Verification of Performance

1. Each reel of cable shall be supplied with a report certifying its performance.

3.9 EXAMINATION

A. Verification of Conditions

1. Contractor will advise the Engineer in writing if conditions are not suitable. It is expected, however, that the Contractor will work in incomplete areas in order to meet the schedule.

B. Protection

1. Protection of existing work that may be affected by damage from other trades is the sole responsibility of the Contractor.

3.10 INSTALLATION

A. All cables, connectors, distribution frames, etc. that comprise this system shall be installed as per manufacturers recommendations, unless otherwise noted.

B. The Contractor shall purchase installation guides from vendors, and become familiar with the installation requirements prior to commencement of the work. Any discrepancies between plans, specifications and the manufacturers recommendations shall be brought to the attention of the Engineer.

C. The plans and specifications indicate the general arrangement and scope of work. To facilitate the installation and coordination with other trades, the Contractor may deviate from this general arrangement so long as the scope does not change. All such changes shall be submitted to the duly authorized Engineer. All such changes shall be made with no additional cost to the Employer.

D. Refer to drawings for data cabinets details & coordinate with university representative.

E. Cables shall be continuous, with no factory or field splices, or intermediate couplings.

F. Contractor shall require where necessary cable support bridges over obstructions i.e. underfloor conduit, pipes, supports, etc.

G. Contractor shall install cable supports and fasteners for horizontal cable.

- Used to keep cable off of black iron, ceiling stringers and ceiling tile.
- Hangers or straps permanently attached to the underside of concrete deck.
- Contractor to bundle cables in groups not to exceed 10 units.
- Straps installed every three feet along a respective cable run.
- Contractor to submit manufacturer’s cut sheets and proposed installation method prior to starting work.

H. Contractor shall provide sufficient slack at all termination locations to allow for proper termination. The Contractor shall not coil cable in ceiling, telephone closets and the main telephone room so as to avoid unnecessarily adding to cable lengths, unless specified.

I. Contractor shall install fire stopping material, filling the interstices between the cable in conduit or floor ceiling assemblies, used to give comparable thermal conductance to the

barrier itself in addition to resisting the fire and restricting the passage of hot gases for the required fire rated time.

3.11 INSPECTION

Conformance to the installation practices covered above are to be verified when completed. In some cases, the customer may inspect before acceptance. The following points are to be examined:

A. Completion of the design documentation.

B. All terminated cables shall be tested as per the specification.

C. Cable type shall be suitable for its pathway.

D. The pathway manufacturer's guidelines shall be followed.

E. The installers shall avoided excessive cable bending.

G. Hanging supports shall be within 150cm.

I. Telecommunications closet terminations shall be compatible with equipment?

H. Patch panel instructions shall be followed? *(Inspect visually.)*

1. Cable dressing first.
2. Jackets (sheath) remain up to the connecting block.
3. Pair terminations tight and undistorted.
4. Twists maintained up to the connecting block.

I. The correct outlet connectors shall be used.

J. The jacket maintained right up to the connection.

K. Fire proofing provided in common cable area.

L. Protection from sharp or movable crushing, impact and construction activity.

3.12 LABELING

1. Permanently attach labels to both ends of all cables.

2. Label shall be typed and covered with clear plastic laminate.

3. Attach label 20cm from end of sheath.

4. Provide unit cost for cable labels and unit labor cost to affix label to cables.

5. Attach self-adhesive labels to top center of each faceplate.

6. Information on labels shall agree with plans. Any discrepancies shall be replaced at the Contractor’s expense.

3.13 ADJUSTING

A. Repair or replace defective work, as directed.

B. Pay for restoring or replacing damaged work found by or due to testing, as directed and at the Contractor's own expense.

3.14 DEMONSTRATION

A. The manufacturer shall demonstrate the operation and verify the accuracy of all equipment to the Engineer or its duly authorized representative.

3.15 PROTECTION

A. After installation, protect from damage during subsequent construction and other normal activities.

END OF SECTION

SECTION 16770

FIRE ALARM SYSTEM

1. GENERAL

1.1.1. ELECTRICAL WORK GENERALLY is to be in accordance with the requirements of Section 16010 of the Specification.

1.1.2. DESCRIPTION OF WORK: complete fire alarm system analog addressable intelligent interactive type including the following:

A. Main fire alarm annunciation and control panel, microprocessor based, analogue / addressable type, modular expandable, fully electronic, electrically supervised. The system will have batteries capable of monitoring the system for 24 hours and then sounding the alarm for 30 minutes

B. Automatic and manual detectors consisting of smoke, heat, manual, duct smoke detectors. Detectors will be located to code and as shown on drawings.

C. Alert devices consisting of sirens and horns and visual alarms. The system must be interfaced with the local fire fighters station at the main panel by telephone dialler.

D. Interface and control modules for releasing of fire rated doors located in between fire zones, and for complete interlocking with lifts, , HVAC, fire dampers, fire pumps, (refer to mechanical drawings for HVAC operation in case of fire).

Contractor shall be fully responsible to determine number of interface control modules as per NFPA requirements & and submit fire strategy to be followed in case of fire, for approval.

E. Complete wiring system, end of line devices and any related accessories.

1.2 REGULATIONS AND STANDARDS: fire alarm system is to be in accordance with the local fire protection Regulations, and in compliance with the following American National Standard where not in contradiction with the Regulations:

A. NFPA No. 72 National Fire Alarm Code - 1993

B. NFPA No. 90A Standard for the Installation of Air Conditioning and Ventilating Systems

C. NFPA No. 101 Life Safety Code

1.2.2. The system and components are to be listed and properly labeled by

Underwriters Laboratories Inc. or approved international equal recognized testing laboratory.

1.2.3. EQUIPMENT DATA: submit complete technical data for approval including codes and standards, manufacturer's catalogues and specification, construction and circuit description in detail for each type of component and technology used. Provide calculations to verify that batteries are rated to cater to the main fire alarm control panel, amplifiers, and repeater panel.

1.2.4. TESTS: equipment is to be tested for quality and operation at the factory, and labeled properly.

1.2.5. SHOP AND CONSTRUCTION DRAWINGS: submit drawings for approval including, but not limited to, the following:

A. complete riser diagram

B. fire command center

C. PC based graphic system indicating zones and location of fire in case of fire incident. (located next to RP at reception desk)

D. detailed system schematic diagram

E. exact routing and layout of all wireways, conduit and cables, giving type and size with calculations to verify satisfactory wire sizes for all circuits

F. exact composition of main and terminal cabinets

G. terminal numbers and wiring diagrams

H. typical installation details of cabinets, detectors, stations, alarm devices etc.

1.2.6. APPROVED MANUFACTURERS: obtain fire alarm system from one of the following or other equal and approved.

A.	Notifier	(USA)
B.	GE	(USA)
C.	Simplex	(USA)
D.	Edwards	(Canada)

1.2.7. EQUIPMENT SUPPLIER is to be authorised distributor of manufacturer, and able to maintain a local staff of specialists for engineering assistance, maintenance and repair.

2. PRODUCTS AND SYSTEMS

2.1. DESIGN, OPERATION AND COMPONENTS

A. DESIGN: fire alarm system is to be an independent, self contained, audibly and visually supervised, analogue addressable, pre-signal system. Manual alarm stations and automatic fire detector and sensor circuits are to be grouped in loops as shown on the Drawings, each loop having control and annunciator module on main fire alarm control and annunciator panel (MFAP).

B. OPERATION: FIRST STAGE Priority One Alarms: upon actuation of any manual station, automatic detector or sprinkler flow switch, the system is to operate as follows:

1. The main control panel will display priority one alarm indicator, address, floor and location and type of detector and sound an audible signal which can be silenced. Any subsequent alarms will cause the audible to sound again. Visually indicate on the LCD control panel the addressable device or circuit of alarm initiation. The green normal LED is to extinguish and the red alarm LED is to light. The buzzer is to pulsate and the first line of the LCD is to indicate real time, number of messages waiting, type of alarm, zone of alarm and time the alarm occurred. The second line is to display the user specified message indicating the floor and exact location that initiated the alarm.

2. the evacuation alarm will sound in the relevant zone where the signal originated, alerting users and staff in that particular floor, the floor above and the floor to evacuate. The evacuation alarm will be by actuating the sounders.

3. the remaining floors will receive the alarm by actuating the sounders at alert The tone shall repeat continuously (unless manually silenced) until the alarm initiating device is restored to normal and system reset. The silencing of an alarm condition is not to prevent the resounding of alarm devices if a subsequent condition occur.

4. Automatically shut down all HVAC systems serving the zone refer to mechanical drawings.

5. Automatically start all stairwell and elevator pressurisation fans as applicable refer to mechanical drawings.

6. Recall all passenger elevators to Closest floor. A common pre-recorded message is to be sounded in all seized elevators.

7. The operator is to acknowledge the alarm by pressing a dedicated button and the buzzer is to silence provided that there isn't an additional alarm pending. If there are additional alarms the operator is to acknowledge all pending alarms before the buzzer is to silence. To silence audible devices the operator is to press the alarm silence button. New alarms are to cause audibles to resound. To reset the system the device is to be cleared first then the reset

button is to be pressed.

C. Priority Two Alarms: Signals originating from duct smoke detectors and will cause the following:

1. the main control panel will display priority two alarm indicator, address, floor and location and type of detector and sound an audible signal which can be silenced. Any subsequent alarms will cause the audible to sound again,

2. if the alarm was initiated from a duct smoke detector, then associated fan is to shut down, refer to mechanical drawings

3. printer will print a hard copy of events (at security desk)

D. SECOND STAGE: The authorised personnel is to evaluate the danger. In case general evacuation is necessary, the authorised personnel can sound the general alarm either at the main control panel or at any manual pull station. If no action is taken in five minutes the system is to switch to general evacuation automatically.

E. SENSITIVITY the system is to be capable of setting the sensitivity of all analogue sensors by point and be capable of displaying the analogue value of the sensor. The system is to automatically identify any analogue sensor which becomes dirty.

F. FAULTS AND WARNINGS: fire alarm system is to give visual and audible warning on main annunciator panel for the following faults:

1. failure or disconnection of power supply
2. failure of fuse or protective device
3. removal of detector head on any initiating circuit
4. break or short circuit in wiring of any initiating or alarm circuit (line isolation to be installed by contractor every 20 detection.
5. each stairwell pressurisation fan that is running
6. each smoke removal fan that is running

G. Faults are not to prevent fire alarm being sounded and are to automatically indicate fault alarm by audible and visual warning. Audible warning is to remain on until silenced by respective cut-off switch whilst red illuminated LED remains on to indicate defective zone. When respective circuit is restored to normal, trouble bell is to sound again until cut- off switch is back to normal, thereby turning off the illuminated LED.

MAIN FIRE ALARM CABINET (MFAP)

A. MFAP TYPE is to be of the intelligent response controller 19” rack mountable, modular in design for ease of installation, maintenance and configuration. The liquid Crystal Display (LCD) that offers at least two

lines of 40 character each is to be built in. The controller is to be able to differentiate between long term drift above the pre-alarm threshold and the fast rise. The unit is to contain a real time clock, a keyboard, buttons to scroll data, front panel switches for reset, alarm, trouble, test and program. The MFAP is to be have a dual audio channel capability to broadcast two messages simultaneously.

B. MFAP ARCHITECTURE: A master polling computer module is to be serially connected to the display computer module. The master polling computer module is to tasked with the database input / output functions, field annunciation panel co-ordination and operating system co-ordination. It is to contain at least 4 Meg of EEPROM memory for data base storage, and is to have at least four mounting connectors for series communication. The display central processing module is to be responsible for message generation and peripheral device support. It is to contain at least 4 Meg of EEPROM memory for message storage, and is to have at least four mounting connectors for series communication such as the printer, and the LCD. Series cards are to be fitted on both computer modules to gather the data and operate the peripherals. Two-way fire-fighter phone system communication is to be fitted.

C. MFAP OPERATION: During normal state the green normal LED is to flash, the first line is to display the time, the number of active points and the number of disabled points. When the panel goes into alarm the green LED is to extinguish and the red alarm LED is to light. The buzzer is to pulsate and the first line of the LCD is to indicate real time, number of messages waiting, type of alarm, zone of alarm and time the alarm occurred. The second line is to display the user specified message indicating the floor and zone that initiated the alarm.

D. VISUAL INDICATORS: twin light-emitting diodes (LED), tamper-proof type, with rated life of at least 40 years.

E. VOLTAGE AND POWER SUPPLY: MFAP is to provide 24 V d.c. to all zone alarm initiating and alarm signalling devices and is to be designed to operate from 220 V a.c., 50 Hz 2-wire, earthed power supply. Power supply is to be an integral part of the main fire alarm panel, switch mode solid state design, with built in transient protection (up to 6 kV), including UL recognised EMI filter, spark gaps and varistors. Additional power supply units are to be provided for the amplifiers. The power supply is to provide diagnostic LEDs to notify operator upon AC power and/or the control unit CPU failure.

F. BATTERY BACK UP ON POWER FAILURE is to exceed 24 hours normal load, followed by full alarm load capability of 30 minutes. Voltage is to be 24 V d.c. Battery is to be gel electrolyte no maintenance type, float charged, with automatic rapid charge at maximum allowable rate for type used. Battery voltmeter, charge/discharge ammeter, low battery alarm bell and pilot light are to be provided.

G. CABINET: sheet steel, wall mounted type, finished in bright red baked enamel, with hinged door secured by lock. Smaller lockable door is to be provided in main door for access for routine checking and servicing. Opening of main door is to expose all components for inspection, adjustment or replacement, without further dismantling.

H. RELAYS: plug-in type, fitted with dust-proof covers, operated at 24 V d.c., with auxiliary contacts rated 250 V, 5 A supplied as necessary to operate other systems interconnected to fire alarm system, as required in the Specification or as shown on the Drawings.

I. LAMP TEST BUTTONS are to be provided to test LEDs or other pilot lights on annunciator panels.

J. AUXILIARY OUTPUTS: MFAP is to be equipped for transmitting several auxiliary outputs to other systems as shown on the Drawings.

CABLING

A. WIRES AND CABLES: Certified to have passed IEC 331 and 332 flame resistance and fire retardant tests, or UL requirements. Working voltage is to be maintained in a flame of 1000 deg. C for at least 20 minutes or 750 deg. C for three hours. Cables are to be silicone rubber insulated, with overall PVC sheath bonding to coated aluminium foil (FP 200 by Pirelli Cables) or MICC cables or other equal and approved. Conductors are to be copper of minimum size 1.5 mm^2 and/or as shown on the Drawings. The wiring is to be true class “A” (UL Listed).

B. CONDUITS AND RACEWAYS: to comply with Section 16118 of the Specification.

MANUAL FIRE ALARM STATION

A. TYPE: pre-signal, pull-down slide face panel type, with break-rod feature, reset to normal position only by use of special key. Initial operation of station is to cause only presignal device to sound. Inserting a key and turning is to initiate a general evacuation alarm.

B. CONSTRUCTION: tamper-proof, surface or semi-recessed mounting, in suitably designed metal box. Exposed parts are to be bright red. Glass rod is to break under firm pressure or moderated impact, no hammer is to be necessary.

C. OPERATION: station is to have operating characteristics compatible with system.

D. INSCRIPTION is to read "PULL-DOWN FOR FIRE ALARM" in raised white characters. Dimensions of inscription are to conform with the Regulations. Other instructions on use of station are to be boldly inscribed.

INTELLIGENT OPTICAL SMOKE DETECTOR

A. DESIGN: Detection principle is multiple light pulse coincidence circuit. Detector shall be conform to EN54-7/9 or UL 268 multi-criteria type detector having capability of determining seriousness of an alarm condition, without the need to communicate with main control unit. Response of detector (which is microprocessor controlled) is determined by set of algorithms with at least eight remotely selectable and predefined algorithm. Optical chamber shall be designed for detection of every type of visible smoke and therefore have a scattering angle larger than 70 degree.

B. MOUNTING: surface or semi-recessed ceiling mounted type, located as shown on the Drawings, with head removable from fixed twist-lock base. Removal of detector head is to interrupt supervisory circuit and cause trouble signal at control panel normal flat surface coverage is to be over 100m² at mounting height of 6m.

C. SENSITIVITY: detector is to have field adjustable, response sensitivity monitored without removal of detector head, by use of metering test points accessible on exterior of detector head.

D. ALARM RESPONSE TIME is to be adjustable, and not exceeding 7 seconds from time combustion product is introduced into detector. Detector is to be capable of detecting a nominal value of 0.006 grams of combustion products per cubic foot of air.

E. REGULATION, PROTECTION AND SUPPRESSION: detector is to have automatic regulation to varying supply voltage (15 V - 28 V d.c.), reverse voltage protection, spike and surge suppression.

F. STATUS INDICATION: detector is to have status indicating LED, flashing under normal operation for visual supervision. When detector is actuated, LED is to latch-on 'steady' and at full brilliance until reset from control panel.

G. PERFORMANCE: detector is to have at least the following performance:

1. nominal operating voltage: 24 V d.c.
2. alarm current: 5 m A
3. quiescent current: less than 200 micro A
4. ambient temperature: -10 to +60 deg. C
5. relative humidity: 10% to 95%
6. smoke entry characteristics: 360 degrees in all directions
7. effectiveness for air-flow: up to 12 m/s.

FIXED TEMPERATURE HEAT DETECTOR

A. TYPE: Dual thermistor sensor is to monitor the ambient temperature from 0 to 60 deg C and give a fast response to fast rapid increase in temperature. Detector is to have plug-in, twist- lock type base, hermetically sealed against dust and moisture, mounted in recessed or surface mounted box compatible with type of installation.

B. OPERATION: to operate at 24 V d.c. nominal voltage.

C. REGULATION, PROTECTION AND SUPPRESSION: detector is to have automatic regulation to varying supply voltage (15 V - 28 V d.c.), reverse voltage protection, spike and surge suppression.

D. STATUS INDICATION: detector is to have status indicating LED, flashing under normal operation for visual supervision. When detector is actuated, LED is to latch-on 'steady' and at full brilliance until reset from control panel.

DUCT SMOKE DETECTOR

A. TYPE: is to be an intelligent, analogue air duct sensor housing the ionisation smoke detector specified above (refer to mechanical drawings).

B. CONSTRUCTION is to be made of high impact plastic with a clear cover for easy viewing of the polling and alarm LED's. Two sampling tubes are to be provide and installed in the duct. Gaskets are to prevent air leakage. For each duct detector a separate alarm and test stations are to be provided.

RATE OF RISE HEAT DETECTOR.

A. Type: Automatic heat detector with fast semiconductor sensor to guarantee reliable detection of fire with rapidly rising temperatures and integrated fixed temperature function for the detection of fires with slow rising temperature.

Intelligent fire detector with decentralized intelligence, automatic self-test, CPU failure mode, alarm and operating data memory, alarm indicator, and soft- addressing.

B. Performance:

1. Nominal operating voltage : 24 VDC.
2. Alarm current: : 5mA.
3. Quiescent current : less than 200 micro A.
4. Ambient temperature : -10 to + 60 deg.C.
5. Response temperature : 54°C to 64°C for 5°C/min. rise.
   32°C to 75°C for 30°C/min. rise.

COMBINED HEAT SMOKE DETECTOR.

A. Type: Multi-sensor detector provided with built-in optical smoke detector and fast detector the optical measurement chamber is provided with enabling developed newly technology, sensor the detection of fire, and fire with high lead generator.

Multi-sensor intelligent heat smoke detector with time-related signal analysis, decentralized intelligence, automatic self-test, CPU failure mode, automatic data memory, alarm indicator and soft addressing.

B. Performance:

1. Nominal operating voltage : 24 VDC.
2. Alarm current: : 5mA.
3. Quiescent current : less than 200 micro A.
4. Ambient temperature : -10 to + 60 deg.C.
5. Response temperature : 54°C to 65°C at 1°C/min. rise.

ADDRESSABLE CONTROL MODULE

The addressable control module shall be designed to convert specific signals on an addressable detection line from the manufacturer's control unit into control functions to actuate fire doors, smoke vents, ventilators etc.

The output contact of the addressable control module shall be rated for at least 0.5A and 220 VAC.

The addressable control module shall have an input for a connection of an external contact to provide a confirmation signal to be sent back to the control unit via the detection line after the control function has been carried out.

The addressable control module shall be connected to the control unit via fully supervised two-wire circuit. No separate power line shall be required.

The control function to be assigned to the addressable control module shall be programmable at the control unit.

The addressable control module shall have screw less terminals with built-in strain limits to prevent permanent deformation of the terminal and weakening of contact pressure.

The addressable control module shall have a protective plastic housing of at least IP-40 IEC protection category.

2.2. OTHER DETECTION SYSTEMS, ALARM AND SUNDRY DEVICES

ALARM AND SUNDRY DEVICES

A. **Low-Power Alarm Sounder and Horn**

- The low-power alarm sounder shall produce a continuous tone and shall be suitable for small to medium size rooms with low background noise level.

- The alarm horn shall be suitable for surface or recess mounting indoors. The electronic signals are diode polarized, heavy duty, tone selectable, weatherproof made of die cast zinc alloy with sage enamel finish.

- Horn with flashing light – this unit to be similar to the horn component described above, and combined in one unit with a strobe (flashing light). The unit to have a red fire lettering and flash approximately one or 2 times per second.

Technical Data

a)	Operating voltage	:	18 to 24 VDC
b)	Power consumption approx.	:	1.8 VA
c)	Sound intensity at 1m distance	:	85 dB/800 Hz.
d)	Ambient temperature (-4 ºF to + 104 ºF)	:	-20 ºC to + 40 ºC
e)	Protection category IEC 529	:	IP 30

3. FIELD AND INSTALLATION WORK

3.1. INSTALLATION

3.1.1. WIRING: FP 200 type cables are to be run on cable trays, in galvanised heavy gauge steel conduit or in duct banks. MICC cable is to be run on cable trays or fixed to wall (for single cable only) in concealed or exposed installations as shown on the Drawings. Wire sizing schedules and calculations are to be submitted to ensure acceptable voltage drop on all alarm circuits within the system and to indicate various zone wiring layouts in detail. All circuits are to be appropriately labelled and approved before handing over the project.

3.1.2. MANUAL STATIONS are to be mounted 1400 mm from finished floor level.

3.1.3. CONNECTIONS AND TERMINATIONS of circuits are to be made only at accessible boxes and fire alarm cabinets.

3.1.4. DETECTOR HEADS with twist-lock mounting are to be removable from floor level by use of pre-engineered grip on end of long rod, specially designed for the purpose.

3.1.5. PANELS AND POWER: Install the panels where indicated and connect to the AC critical care and life safety power supply, DC standby power, alarm circuits, supervisory circuits, signal circuits, local and remote annunciators, , smoke control dampers, fan shut downs, elevator controllers, smoke exhaust fans, and all other devices.

3.1.6. AUTOMATIC DEVICES LOCATION: Install product of combustion and automatic alarm initiating devices as indicated and connect to alarm circuit wiring. Co-ordinate device location with mechanical air diffusers (minimum 600 mm away) and other equipment.

3.1.7. DOOR HOLDERS: Connect from the fire alarm system to the designated doors so that operation of the fire alarm system shall release all doors equipped with electric hold-open or locking devices (refer to architectural drawings).

3.1.8. CONNECTIONS TO OTHER SYSTEMS: Connect from the fire alarm system to the lifts, HVAC system emergency generator(s) and fire pump(s) control panels to monitor operation as indicated on mechanical and electrical drawings and specifications.

3.2. TESTING AND ADJUSTING

3.2.1. EQUIPMENT AND LABOUR: provide equipment and labour for site testing of detector heads and sensors including set of shorting plugs with connectors for checking wiring to sensor and detector sockets, and test bench equipment for checking and calibration of all items of system.

3.2.2. TEST FIRES: ensure correct positioning of each automatic detector. Start test fires and measure MPCM (milligrams particulate per cubic meter) using particle detector.

3.2.3. ADJUSTMENT AND TESTS: when exact optimum positions are determined, adjust sensitivity of automatic detectors for optimum safety to false alarms ratio and carry out the following tests:

A. On heads and sensors of all types: check operation at required threshold using test equipment and methods specified by the manufacturer

B. On all circuits: verification of operation of fault indication for open circuit, short-circuit, earthing, excessive resistance or leakage and removal of heads

C. General check of functions for main annunciator panel and repeater.

3.2.4. THE MANUFACTURER is to make, inspect and test the fire alarm equipment, including those components necessary to the direct operation of the system such as manual stations, thermal detectors, smoke detectors, flow switches, bells and controls, to ensure the following (coordinated between system vendor and contractor).

A. That the type of equipment installed is that designated by the engineer's specifications.

B. That the wiring connections to all equipment components show that the installer observed code requirements.

C. That the manufacturer's equipment has been installed in accordance with the manufacturer's recommendations and that all signalling devices of whatever manufacturer have been operated or tested to verify their operation.

D. That the supervisory wiring of those items of equipment connected to a supervised circuit is operating and that the governmental regulations, if any, concerning such supervisory wiring, have been met to the satisfaction of inspecting officials.

3.2.5. THE MANUFACTURER (or system vendor) is to supply to the Trade of this Division technical assistance with respect to any changes necessary to conform the work to paragraphs above. During the period of inspection by the manufacturer, this Division shall make available to the manufacturer, electricians as designated by the manufacturer. To assist this Division in preparing the bid, the manufacturer shall indicate the number of hours necessary to complete this inspection, prior to closing of tenders.

3.2.6. INSPECTION CERTIFICATE: On completion of the inspection and when all of the above conditions have been complied with, the manufacturer shall issue to the Consultant:

A. A copy of the inspecting technician's report showing location of each device and certifying the test results of each.

B. A certificate of verification confirming that the inspection has been completed and showing the conditions upon which such inspection and certification has been rendered.

3.2.7. INSPECTION COSTS: all costs involved in this inspection both from the manufacturer and this Division shall be included with this Division's total price and it will be the responsibility of this Division to ensure that the manufacturer carries out all the work listed herein to the satisfaction of the Consultant.

3.2.8. INSTRUCTIONS AND TRAINING: The manufacturer is to provide the services of a competent alarm system technician to instruct the staff in the operation and maintenance of the system.

3.2.9. VERIFICATION BY AN ENGINEER: This Contractor is to arrange and pay for the services of an independent engineer to verify the complete fire alarm system and to submit 3 copies of his verification report signed and sealed to the Consultant. Prior to his verification, contractor shall provide the following:

A. A copy of the manufacturer's verification report 7 days prior to engineer's verification.

B. Leaving the devices connected, loosen mounting screws on all fire alarm initiating devices in a condition for verification.

C. Co-ordinate with mechanical trade so that the testing and verification

of the fire protection affecting the fire alarm system can be done at the same time.

D. A set of "As-Built" drawings on the installed fire alarm system.

E. Give notice to the engineer at least two working days prior to his verification.

F. During engineer's verification, electrical contractor shall have his electrician and a manufacturer's technician to accompany with and to follow engineer's instructions.

G. Inform the Consultant of the timing of the verification so that he can also witness it.

H. Submit the name of the engineer to the consultant for approval.

I. The cost for the independent engineer's time is to be included in Contract.

END OF SECTION

SECTION 16771

AUDIOVISUAL INTERPHONE SYSTEM

1. GENERAL

The contractor shall allow for the supply, install, test and commission the Audio video interphone system, as herein specified and shown on the drawings. The system shall consist of 1 master video interphone station at the main entrance of the building, & color monitors located in the apartments and offices as shown on drawings..

2. SYSTEM FEATURES

The basic function of the system shall be to facilitate communication between a visitor at the main entrance and the tenant. The visitor initiates a call by punching a button. A buzzer alerts the tenant of a visitor, answers the call and an audio communication link shall be established between the entrance panel and the tenant monitor. The monitor handset shall have a push button to release the solenoid lock at the entrance door to allow the visitor in.

Each entrance panel and monitor station shall be installed as shown on the drawings. With all interconnection wiring, conduits and accessories. The conduit system shall be segregated from all other systems.

3. MONITOR STATIONS (SLAVE STATION).

The video monitor shall be surface mounted type with flat screen and high image quality. The monitor shall have 4” screen electronic call, LED for various signals, brightness, contrast and call volume controls. The unit shall be complete with door opening button.

4. MASTER INTERPHONE STATION(MAIN ENTRANCE UNIT).

Each main entrance unit/door station shall be flush mounted with an illuminated push button, color camera unit, microphone / speaker all as a built in unit. The faceplate shall be of thick anodized aluminum with block color finish with rounded aluminum push button. It shall consist of an audio-video module,

The audio-video module shall have manually oriented 1/3” CCD color TV camera, infrared illuminated LED, speaker unit with double amplifier and volume adjustment.

Electric latches and solenoid locks shall be included in this system the contractor shall co-ordinate and insure that the operation of the locks is possible via push buttons from the Audio-visual interphone system.

5. APPROVED MANUFACTURER.

- Bticino.
- Videx.
- Urmet.
- Golmar

Or approved equal.

END OF SECTION

SECTION 16781

CCTV SECURITY SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Specification sections, apply to this Section.

B. Requirements of the following Division-16 sections apply to this Section:

1. "16110, 16135".

1.2 SUMMARY

A. This section includes a closed circuit television (CCTV) system.

B. System is to consist of the following basic components:

- Color cameras for general surveillance with protective housing
- Video distribution controller.
- Power supply units.
- Color monitor
- DVR (1.5 TB HD, realtime, PC based).

C. The work to be done as outlined hereunder includes the furnishing of all labor, supervision, and equipment for the performance of the installation work specified by this contract and any associated work required as necessary for the completion of the installation hereinafter specified and as may be required.

D The Security Contractor shall furnish all equipment and all incidental materials such as the necessary connecting hardware, etc. wiremold, cable and wire, mounting hardware, etc. which are necessary to complete the installation of this security system. All materials and workmanship provided by the Contractor shall be in accordance with the best practice of the state-of-the-art of the security systems installation trade.

E The installation shall be suitable in every respect for satisfactory operation that will require a minimum amount of maintenance.

F. It shall be the Security Contractor's responsibility to see that the equipment is installed to manufacturer's specifications and that the correct power is supplied to each different type of equipment.

G. It shall be the Security Contractor's responsibility to obtain necessary equipment manufacturer's installation specifications and drawings to complete all installation and contract work.

H. All electronic equipment shall be grounded as required by manufacturer's specifications. All cabinets, junction boxes, control cabinets, etc. shall be grounded.

I. The Contractor shall note the locations of CCTV cameras shown on drawings are the preferred areas of placement. However, the Contractor shall be responsible for the final location of each camera for optimal coverage and stability. The cameras shall be placed to provide optimum surveillance field of view.

J. CCTV System Functional Description: System generates video images, processes them and distributes them to monitors, and record these images at the dedicated hard disc. All cameras shall be controlled from a control panel next to DVR. System is to ensure remote control for video camera equipment.

K. Related Sections: The following sections contains requirements that relate to this section:

1. "Wires and Cable".
2. "Raceways".
3. "Electrical Cabinets, Boxes and Fittings".

1.3 **SUBMITTALS**

A. General: Submit the following according to the Conditions of the Contract and Specification sections.

B. Product Data: for products specified in this section. Include data on features, components, ratings, and performance. Include dimensional plan and elevation views of components and enclosures and details of control panels. Show access and working space requirements.

C. Maintenance Data: for systems and products to include in "Operating and Maintenance Manual" specified in Division 1. Include the following:

1. Detailed operating instructions covering operation both under normal and abnormal conditions.
2. Routine maintenance requirements for system components.
3. Lists of spare parts and replacement components recommended to be stored at the site for ready access.

D. Wiring Diagrams: detailing internal and interconnecting wiring for power, signal and control and that distinguishes between field-installed and factory-installed wiring.

E. Product Certificates signed by the manufacturer certifying products comply with specified requirements.

F. Qualification data for manufacturer and installer as specified in "Quality Assurance" Article. Data describes capabilities and experience.

H. Field test reports for all tests required for system operation, certified by an official testing authority.

I. Shop and Construction Drawings: Submit drawings for approval including, but not be limited to:

- detailed schematic diagrams
- configuration and construction details of control cabinet, and operating consoles
- console and cabinet layouts with equipment located in as-installed positions.
- complete and detail cable routing.

Wiring diagrams are to bear manufacturer's signature indicating that they have reviewed the drawings and that they are correct with regard to sizes, wiring and configuration and will operate in accordance with function, scope and intent of the specifications.

1.4 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms experienced in manufacturing systems and equipment of the same types and capacities used for this project that they have a record of successful in-service performance.

B. Service Center: Select a system manufacturer who maintains a service center capable of providing training, parts, and emergency maintenance and repairs at the project site with a 24-hour maximum response time.

C. Installer Qualifications: Engage an experienced installer who is a factory-authorized service representative of the system manufacturer to supervise system installations.

D. Codes and Standards: The installation shall meet, as applicable, to Underwriter's Laboratories (UL), NEMA, & NEC requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS:

A. Manufacturers: Subject to compliance, manufacturers offering products that may be incorporated in the work include, but are not limited to, the following:

Vision
Pelco
American Dynamics
Honeywell
Sony

DVR: Vision, Honeywell

or other equal and approved.

2.2 SYSTEM REQUIREMENTS

The equipment proposed must have equivalent or better performance than the below.

2.2.1 ANALOG COLOR CAMERAS

Features

- 1/3" interline color CCD
- Vertical phase adjustment

*Built in IR sensitive mechanical day/night filter

- IR, Night & Day, Auto Iris
- 2D/3DNR, noise reduction
- High resolution of 600TVL at day & 650TVL at night
- Compact, lightweight
- Automatic electronic iris
- Low power consumption
- 0.01 lux low light sensitivity
- IP66 Weather & vandal prrof
- Automatic electronic shutter
- Top and bottom mounting holes
- Switchable back-light compensation
- Super Wide Dynamic

*Extended IR LED's life cycle & sensitivity *Highlight eclipse
* Stabilizer (Compensates Camera Movement)
*Motion Detection

Technical Specification

Image Sensor	1/3" CCD, 2.8-12mm DC IRIS lens
Image Area	4.82 H x 3.64 mm V
Synchronizing System	Line locked
Auto Iris Control	VIDEO iris/DC iris
Back-Light Compensation	ON/OFF switch and level adjuster
Motion detection interface	Yes
Dome bubble rotation	Yes
Mounting arrangement	Industrial type
Easy to use OSD functions	

Electrical Requirements

Input Power	12VDC/24 Vac + 20%/10%
Surge Protection	Yes

2.2.2. ENVIRONMENTAL CAMERA HOUSING

Housing shall be made of extruded and cast aluminium with IP 66 degree of protection. It shall ensure full and easy access to the camera and lens for trouble-free installation and servicing.

The camera platform shall have four lenses, of height adjustment and shall be secured in any position along the full length of the housing.

The platform shall be constructed of non-conductive material in order to eliminate grounding problem.

The housing shall have a powder coat enamel finish and shall be marine elimate resistance. A low current PTC shall automatically provide heat in the housing in order to maintain a clear viewing window.

2.2.3 COLOR MONITOR

Features

- 700 lines of horizontal resolution
- Rugged, attractively styled cabinet
- Convenient front controls
- VCR-matched time constants for excellent
- Playback characteristics
- Switchable DC restoration
- Switchable over scan/under scan
- Looping input with automatic
- 75 ohm
- LED power indicator
- Low power consumption

2.2.4. DIGITAL VIDEO RECORDING (DVR)

A. General

DVR to be real time, transaction based recording of up to 16 analog cameras, with a record rate of 300 fps minimum, with 1.5TB hard disc drive to record at real time speed at least 15 days. The DVR should be networkable and includes a CD writer for back up, and with the following minimum requirements;
Industry-leading ATM, tellers, and alarm interfaces
Programmable video recording & retention
Embedded operating system for enhanced security
RAID 1 option
Video search by date/time/transaction/number or event
Able to communicate with same application used for all other FDC buildings.
Compression: MPEG-4 (SM-4)
Resolution: CIF/2CIF/4CIF
Frame rate: 60/120/300fps (NTSC), 50/100/240fps(PAL)
Embedded linux based operating system
Storage: 1.5TB with independent surveillance, motion, and event/transaction settings.

B. Tape Transport

Recording Modes

Resolution
- Over 600-650 TV lines horizontal (color)

Luminance Signal
Frequency modulation recording

Input
0.5 to 2.0 Vp-p, BNC, 75 Ω, unbalanced.

Output
1.0 Vp-p, BNC, 75 Ω, unbalanced

S/N ratio
Greater than 45 dB.

D. On-Screen Data Display

Contact
Menus for setting day-present time, display format, timer programs (day of weeks, start/stop), user selection menus (alarm recording, tape condition, emergency recording, clock out, mode out, one-shot recording, buzzer, playback heads), default selections, power loss displays and alarm recording-elapsed time display.

Position On-Screen
Any position, sizes.

E. Alarm Response
Automatic alarm search.

F. Timer
- Eight start and stop times within a one week time period.
- Programmable recording speed.

G. Mechanical
Cabinet shall be rack mountable.

H. Environmental

Operating Temperature
+5° C to 40° C.

Humidity
85% RH (non-condensing).

I. Regulatory Approvals

- UL listed
- CSA certified.

Or approved equal

PART 3 - EXECUTION

3.1 **CCTV SYSTEM INSTALLATION:**

A. Camera Mounting: Install cameras in the general vicinity indicated, adjusted to final locations defined by camera location tests. Provide adequate headroom below cameras and their mountings. Where necessary, change the type of mounting to provide adequate headroom below.

3.2 **IDENTIFICATION:**

A. Identify: system components, wiring, cabling, and terminals according to Division 16 Section "Electrical Identification".

3.3 FIELD QUALITY CONTROL:

A. Manufacturer's Field Services: Provide services of factory-authorized service representatives to supervise the field assembly and connection of components and system pretesting, testing, and adjustment.

B. Inspection: Verify that units and controls are properly labeled and interconnecting wires and terminals are identified.

C. Pretesting: Align and adjust the system and pretest all components, wiring , and functions to verify they conform to specified requirements. Replace malfunctioning or damaged items with new items. Retest until achieving satisfactory performance and conditions.

D. Final Acceptance Testing Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 2 weeks. Provide a minimum of 10 days' notice of acceptance test performance schedule.

F. CCTV Camera Location Test: Support each camera temporarily at the location indicated and connect to monitor. Adjust camera location and mounting and substitute fixed lenses as approved to provide required performance at monitor. Adjust locations within 15 feet (5m) of those indicated with no change in Contract cost.

G. Record: results of tests.

H. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

3.4 CLEANING:

A. Clean: all system components including camera housing windows, lenses, and monitor screens. Use methods and materials recommended by manufacturer.

3.5 ADJUSTMENT:

A. Occupancy Adjustments: When requested within 1 year of date of Substantial Completion, provide on-site assistance in adjusting the system to suit actual occupied conditions. Provide up to 2 requested adjustment periods at the site for this purpose without additional cost.

3.6 DEMONSTRATION:

A. Training: Arrange and pay for the services of a factory-authorized service representative to demonstrate adjustment, operation, and maintenance of the system and to train Owner's personnel. Include demonstration of methods to determine optimum settings for system controls.

END OF SECTION

SECTION 16610

UNINTERRUPTIBLE POWER SUPPLY SYSTEM

PART 1 - GENERAL

1.01 PURPOSE

The purpose of this specification is to define the design, manufacture and testing characteristics required in view of supplying and putting into operation an Uninterruptible Power Supply (referred to as a UPS in the rest of this document).

1.02 SUMMARY

Provide labor, materials, equipment and services, and perform operations required for installation of uninterruptible power supply systems and related work as indicated on the drawings and specified herein.

Only equipment that carries the certification and approval label of TUV or UL testing laboratories shall be approved.

The UPS system shall be capable to operate continuously providing uninterrupted and regulated power in the event of a power distribution to the connected load up to the specified battery autonomy.

The work shall include, but not be limited to, the following:

1. Solid-state rectifiers / chargers.
2. Static inverters.
3. Static transfer switches.
4. Maintenance bypass switches.
5. Batteries.
6. Accessories.
7. Furnishing load bands and test instruments during field-testing.

The UPS system shall be capable of withstanding any combination of the following environmental conditions in which it must operate, without mechanical or electrical damage or degradation of operating characteristics.

a. Ambient temperature = 0 deg. C to 45 deg. C.
b. Relative humidity = 0 % to 95% (non-condensing).

System efficiency = 92% at full load.

Type of UPS = ON LINE = using intelligent microprocessor and insulated gate bipolar transistor (IGBT) power semi-conductor technology.
The unit shall be compact and discreet. It shall integrate perfectly in the site.

1.03 SUMMARY

The UPS shall be of the latest technology (IGBT) in the field combining modular power circuit design with high frequency chopping (15 kHz). It shall feature:

a. Continuity of supply for 15 minutes at 60% load.
b. Instant response to load steps
c. High reliability.
d. A diagnostic panel.
e. Communication facilities: Possibility for remote-control and monitoring, UPS administration on a LAN or WAN, connection on an Ethernet network for SNMP integration, multi-platform and multiple servers supervision and shutdown, load shedding by software control of different sockets.

1.04 PRINCIPLE OF WORK

A rectifier charger shall take the input mains to supply the inverter and shall keep the batter constantly charged.

The inverter shall supply a perfect, constant alternating current to the load with referenced neutral at all times.

In case of mains failure, the battery backup-shall takeover the supply to the inverter. This shall take place without any disturbances to the output.

The battery shall supply the inverter until its autonomy is exhausted.

In case of overload or a fault, the load shall be supplied directly from the normal power via a static switch.

1.05 FUNCTIONS

The UPS shall comprise:

a. A safety device.
b. A rectifier charger, producing DC from AC.
c. An inverter, to restore perfectly AC power.
d. A built-sealed lead acid battery for backup supply shall be provided on rack installation.
e. A static switch.
f. An integrated manual bypass for maintenance without load interruptions.

1.06 COMPLIANCE TO STANDARDS

a. IEC 146.4
IEC 801-2/3/4 OR IEC 1000-4-2/3/4/.
EN 5091-1
IEC 1000-2-.

Furthermore the required units shall comply with the European Directives or equivalent regarding Electromagnetic Compatibility

b. ISO 9001 official certificate for design and production to be submitted.

1.07 QUALITY ASSURANCE

Materials and equipment shall conform to the latest edition of reference specifications specified herein and to applicable codes and requirements of local authorities having jurisdiction.

1. Code Compliance: Comply with the applicable electrical code as applicable to installation and construction of electrical equipment.
2. IEC Standards: Comply with IEC standard 146 and 439.
3. VDE Standards: VDE 0875 cl. N – Radio Interference suppression.

Manufacturer's Qualifications: Firms regularly engaged in manufacture of uninterruptible power supply systems, of types and ratings specified whose products have been in satisfactory use in similar service for not less than 5 years. A list of installed systems of the same type and ratings as specified shall be submitted to the Engineer.

1.08 SUBMITTALS

Submit the following in accordance with Submittal Requirements specified in SUB-SECTION 16010.

1. Product Data: Submit manufacturer's data on uninterruptible power supply systems and components.
2. Shop Drawings: Submit dimensioned layout drawings and descriptive data of UPS systems and accessories including, but not limited to, weights, rectifiers / chargers, inverters, static transfer switches, maintenance switches, batteries and instruments, indicating accurately scaled UPS system equipment location and their spatial relationship to associated equipment; show connections to normal and standby power supplies, elementary diagrams of protection, control and instrumentation systems, wiring and single line diagrams, time current curves of protective devices. Submit calculations to indicate compliance with battery requirements of scheduled standby use with no more than specified drop in battery voltage.

3. Maintenance Data: Submit maintenance data, parts and recommended spare parts list for uninterruptible power supply and accessory' including "troubleshooting" maintenance guide. Include this data, product data, and shop drawings in maintenance manual; in accordance with requirements of SUB-SECTION 16010.

4. Field Test Procedure: Submit a detailed site acceptance test procedure.

5. Submit a failure mode and effects analysis and a reliability prediction based on the final design.

6. Submit a detailed factory acceptance test procedure.

7. Submit certified factory and site test data and reports, for the UPS equipment and the batteries.

8. Submit battery manufacturer name, container type, the total number of containers required per UPS module, battery and rack dimensions and weights.

1.09 DELIVERY, STORAGE AND HANDLING

Handle uninterruptible power supply equipment carefully to prevent damage, breaking and scoring. Do not install damaged units or components, replace with new.

Store units in clean dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.

1.10 WARRANTY AND GUARANTY

The UPS system warranty shall be no less than one year after initial handing over, and must include repair, parts, labor. The manufacturer shall respond to requests for and provide warranty service within 8 hours maximum.

Battery: The battery provided herein shall be guaranteed by the UPS manufacturer on a pro rated basis for five years (unless otherwise specified herein), provided that the prevailing ambient temperature of the battery area does not exceed 80 °F. batteries shall deliver a minimum of 100% of rated capainitially and a minimum of 80% of rated capacity at the end of the battery guarantee period in accordance with IEE standard 485.

Efficiency: The manufacturer shall guaranty, in writing, the stated system efficiency. If the stated efficiency is less that that stated, the manufacturer shall refund to the user and amount based on additional power costs incurred by loss of efficiency over a three-year operating period.

1.11 MANUFACTURERS

Manufacturers: Subject to compliance with requirements, provide uninterruptible power supply systems of one of the following:

1 UPS:

a. MGE
b. Socomec

2. Battery :

a. Oldham.
b. Exide.
c. Alcad.

Provide on calculation sheet the following data:

- Float and low dc voltages with supporting documents from the UPS manufacturer.
- Float and low dc voltage per element with supporting documents from the batteries manufacturer.
- Calculation of the required number of element and selection of the batteries model according to calculated power in Kw.

3. Batteries and Racks:

   a. The battery shall be of the sealed maintenance free lead acid gas type, with a five years Certified guarantee from main supplier, suitable for office environment, have no gassing and need no watering or special ventilation.

   b. Battery banks shall be arranged to minimize the requirements for floor space, consistent with providing for safe servicing of the cells and with a maximum of three tiers high. Provide suitable Code approved steel racks for support of batteries. Racks shall be protected with battery electrolyte resistant paint. Racks shall be designed, constructed and braced for the site seismic zone.

4. Contractor shall submit the following certified documents from UPS supplier:

   a. Float and low DC voltage per battery element with supporting document form the batteries manufacturer.

   b. Calculation of the required number of element and selection of the batteries model according to calculated power in KW.

1.12 SOURCE QUALITY CONTROL

Factory Tests: before shipment, the manufacturer shall fully test the system to assure compliance with the specification. These tests shall include operational discharge and recharge test on at least a one-minute batter plant to assure guaranteed rated performance.

1.13 EXAMINATION

Examine conditions at the job site where work of this Section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

1.14 PREPARATION

Examine the Contract Drawings and specification in order to insure the completeness of the work required under this Section.

Verify measurements and dimensions at the job site and cooperate in the coordination and scheduling of the work of this Section with the work of related trades so as not to delay job progress.

Provide templates as required to related trade for location of items.

PART 2 - PRODUCTS

2.01 PREPARATION

The double-conversion UPS (also called on-line) shall operate as defined below.

A. Normal Operation:

(Normal AC source available)

The rectifier / charger supplies the inverter with DC current while simultaneously float charging the battery. The load is continuously supplied with dependable electrical power by the inverter.

B. Operation by Battery Power:

(Normal AC source not available or outside tolerances)

Upon failure or excessive deterioration of the normal AC source, the inverter shall continue to supply the load from battery power without interruption or disturbance, within the limits imposed by the specified batter backup time.

C. Battery Recharge:

(Normal AC source restored).

When the normal AC source is restored, the rectifier / charger shall again power the inverter, without interruption or disturbance to the load, while automatically recharging the battery.

D. Static Bypass Operation (Static Switch):

Not required

E. Operation of the Manual Maintenance Bypass:

The UPS shall include a manually operated mechanical bypass system for maintenance purposes.

For personnel safety during servicing or testing, this system shall be designed to isolate the rectifier / charger, inverter and static switch while continuing to supply power to the load from the bypass AC source.

Transfer to the manual bypass mode and back shall be possible without interruption to the load.

The UPS shall also include a device making it possible to isolate the rectifier / charger from the normal AC source.

F. Battery Maintenance:

For safe maintenance on the battery, the system shall include a circuit breaker to isolate the battery from the rectifier / charger and the inverter.

When the battery is isolated from the system, the UPS shall continue to supply the load without interruption or disturbance, except in the event of a normal AC source outage.

PART 3 - EXECUTION

3.01 INSTALLATION

Install UPS system equipment and components as indicated, in accordance with equipment manufacturer's written instructions, and under the direct supervision of the manufacturer's field service engineer and with recognized industry practices to ensure that UPS system equipment complies with requirements. Comply with requirements of the applicable electrical code.

Engage battery manufacturer to provide constant on-site supervision of the battery and battery rack installation, testing and certification. Provide certification that the installation is in compliance with the battery manufacturer's instructions that the manufacturer is satisfied with installation, and that the manufacturer's warranty is in effect. The battery and battery rack installation shall be in accordance with IEC standards and certified with tests witnessed by the Employer's representative.

Grounding: provide equipment-grounding connections for UPS system. Tighten connections to fulfill manufacturer's torquing requirements.

3.02 DEMONSTRATION

Upon completion of installation of UPS system equipment, and after building circuitry has been energized with normal power source, test UPS system, with manufacturer's field service engineer present, to demonstrate capability and compliance with requirements. Where possible, correct malfunctioning units at site, then retest to demonstrate compliance; otherwise remove and replace with new units, and proceed with retesting.
Demonstrate operating procedures to Employer's personnel and provide written operating instructions with full explanation of technical information.

3.03 MAINTENANCE AND RELIABILITY

A self-test system shall be included to monitor the UPS operation continuously and shall identify any faulty sub-assemblies in the event of a failure.

The sub-assemblies shall be laid out for easy replacement.

A manually operated mechanical by-pass switch to isolate the UPS system and static by-pass switch for maintenance purposes while maintaining load power via the by-pass source without interruption shall be provided. It shall be of make-before-break type. The switch shall be entirely mechanically operated.

An integral battery circuit breaker shall also be provided within the UPS panel to isolate the battery from the rectifier / charger and the inverter for battery maintenance purposes.

3.04 STANDARDS AND TESTS

All equipment shall be designed and built in accordance with accepted engineering practice and applicable international standards, in particular the standards listed below.

- IEC 146-4: UPS – Performance.
- EN 50091-1: UPS – Safety.
- EN 50091-2: UPS – EMC.
- ENV 50091-3: UPS – Performance.
- IEC 60950 – EN 60950: safety of IT equipment, including electrical business equipment.
- IEC 61000-2-2: Compatibility levels for low-frequency conducted disturbances and signaling in public low-voltage power supply systems.
- IEC 61000-3-4: Limits for harmonic current emissions (equipment input current > 16 A/ph).
- IEC 61000-4: EMC – electrical fast transient / burs immunity.
- EN 55011: Limits and methods of measurement of radio interference characteristics of industrial, scientific and medical (ISM) radio-frequency equipment – level A conducted and radiated emissions.

The manufacturer shall provide, on request, a complete qualification file demonstrating compliance with the above standards.

The indicated levels of performance shall be confirmed by certification from independent laboratories TUV, or UL and properly labelled.

3.05 REPLACEMENT PARTS

the supplier undertakes to provide replacement parts for at least ten years following the date of delivery.

All spare parts related to this UPS shall be available at the local representative.

3.06 WARRANTY

The rectifier / charger and inverter subassemblies shall be guaranteed (parts and labor on site) for one year following the initial handing over.

Sealed lead-acid battery shall be covered by the same warranty as the UPS.

END OF SECTION

SECTION 16950

ELECTRICAL TESTS

PART 1 - GENERAL

1.01 SUMMARY

A. Provide labor, materials, temporary wiring, testing equipment, load bank, technical supervision and services, and perform operations required for testing of electrical equipment and installations and related work as specified herein and as shown on the drawings.

B. Work Included: The work shall include, but not be limited to, the following:

1. Preliminary inspections and tests.
2. Electrical acceptance tests.
3. Operational tests.

C. Related Work Specified Elsewhere

1. Basic Electrical Requirements - Section 16010.
2. Other Division 16 sections.

1.02 DESCRIPTION

A. Preliminary testing and visual inspections shall be conducted prior to acceptance and operational tests to avoid delays. **Contractor to submit for approval his testing procedure for each electrical system. Tests shall be conducted by contactor according to the approved testing procedure. All tests shall be conducted & recorded and submitted during handing over.**

B. Electrical acceptance tests shall be conducted to assure that electrical materials, and their installations are in accordance with contract documents, regulatory agencies, applicable codes and standards listed herein, and that they may be energized.

C. Operational tests shall be conducted to assure capability of equipment and systems to perform as specified and designed.

1.03 QUALITY ASSURANCE

A. Testing and testing equipment shall conform to the latest edition of reference specifications specified herein and to applicable codes and requirements of IEC chapter 6.
Third party organization certificate is required for Lifts

B. The Personnel engaged in the testing of electrical equipment and systems shall have a minimum of five (5) years of continuous experience in the testing of

the equipment and systems to be tested. Submit evidence of such qualifications to the Engineer.

C. Contractor shall furnish testing equipment as required. Testing equipment, meters and instruments shall have been properly calibrated and certified within (6) months prior to testing and shall be in satisfactory condition to perform its functions.

D. Contractor shall provide an appropriate and stable source of electrical power to the test locations.

E. Perform tests in the presence of the Employer's Representative.

F. Electrical equipment and installation shall meet acceptance and operational tests. Promptly repair or replace defective work and repeat the tests until the particular system and component parts thereof receive the approval of the Engineer. Any damages resulting from tests shall be repaired and/or damaged materials replaced, to the satisfaction of the Engineer.

G. It is essential that certain trades and manufacturer's technical representatives be present during the testing. These representatives shall include:

1. Electrical subcontractor who is thoroughly familiar with the project as to its intent, what equipment has been provided and how it is supposed to operate.
2. Supplier of equipment particularly where packaged equipment has been provided.
3. Manufacturer's representative who is thoroughly familiar with the operation of the equipment.

H. The operation of the electrical installation by the Employers does not constitute an acceptance of the electrical installations. Final acceptance will depend on Contractor's demonstration of compliance with contract documents, completion of adjustments as specified and required, and submission of required documentation and certification of approval by governing authorities.

I. Continuity tests shall be performed using direct current and audible bells or buzzers. Use of telephones is not acceptable.

J. Safety devices such as rubber gloves and blankets, glow detectors, hot sticks, helmets, eye shields, protective screens and barriers, danger signs, etc. shall be used to adequately protected and warn personnel in the vicinity of the tests.

1.04 SCHEDULING

A. Scheduling of tests shall be as approved by the Engineer.

B. Schedule tests so that equipment can be energized immediately after completing the tests and approval of the reports.

C. Notify the Engineer two (2) weeks prior to testing.

1.05 SUBMITTALS

A. Submit the following in accordance with the requirements specified under "Submittals" in Section 16010.

1. Submit two (2) copies of test reports including actual readings and corrected readings after each test period.

2. Submit four (4) bound copies of final approved test reports at the completion of tests.

3. Test reports shall be signed by the persons performing the tests and the witnesses to the tests and include but not be limited to the following data:

a. Date of test.
b. Description of equipment tested.
c. Description of test.
d. Test results.
e. Conclusions and recommendations.
f. Identification of test equipment.

4. Include copies of the final approved test reports in the maintenance manuals.

PART 2 - PRODUCTS

NOT USED

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine conditions at the job site where work of this Section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

3.02 PREPARATION

A. Examine the Contract Drawings and specifications in order to insure the completeness of the work required under this Section.

B. Cooperate in the coordination and scheduling of the work of this Section with the work of related trades, so as not to delay job progress.

C. Testing of outdoor equipment shall not be performed during inclement weather. Ground resistance tests on direct buried ground conductors or rods shall not be performed within 48 hours after rainfall.

D. Megger and high potential testing shall not be performed during periods of high relative humidity. A guard shall be stationed at each location where exposed cables, buswork, connections or other components exist during megger and high potential testing.

E. Equipment shall be thoroughly cleaned prior to testing. Vacuum the interiors of cubicles and remove foreign material. Insulators, bushing and bus supports shall be wiped clean with a lint free cloth.

F. Preliminary tests and visual inspections of the electrical installation including verification checks of factory wiring shall be conducted prior to electrical acceptance and operational tests to avoid delays, and to assure that equipment and installations are free of faulty conditions prior to the application of test voltages.

G. Where the equipment or system under test is interrelated with and depends upon other equipment, systems and/or controls for proper operation, functioning and performance, the latter shall be operated simultaneously with the equipment or system under test.

H. Test fuses for continuity.

I. Test current transformers for continuity and proper polarity.

J. Test potential transformers for continuity and absence of short circuits.

K. Set protective devices in accordance with the approved coordination study.

L. If generators, motors or transformers require drying out to obtain the required insulation valves, the drying method shall be in accordance with the manufacturer's recommendations.

M. Verify that shipping devices and restraints have been removed.

N. Check for proper interconnection and tightness at connections of shipping sections.

3.03 APPLICATION

A. Equipment that can be paralleled under any conditions including interlock defeat shall be tested for proper phasing using hot-phase hot-stick or other approved methods. This includes, but is not limited to, primary selector switches, automatic transfer switches, tie breakers and busses, etc. at medium and low voltage levels.

B. Full load currents of feeders serving single phase loads shall be measured to assure an equal load balance on each phase. Branch circuits shall be reconnected if necessary to achieve this balance.

C. Megger values specified are minimum acceptable values at an ambient temperature of 60 degrees F and low relative humidity. Contractor shall convert readings to equivalent values at 60 degrees F if measurements are taken under other conditions.

C. The phase rotation at busses, panels, switchboards, switchgear, etc., shall be checked and verified using a phase sequence meter for consistency and conformity to recognized standards, i.e. A-B-C left to right, top to bottom, front to back, when facing front of the equipment, and to provide an A-B-C (1-2-3) clockwise rotation. Where electrical installations and extensions of existing systems, or in new buildings at existing sites, phase rotation shall conform to the existing.

3.04 TESTS

A. Low Voltage Wire and Cable (600 Volts and Less)

1. Wire and cable shall be tested for continuity, freedom from short circuits and grounds and meggered to assure adequate insulation resistances for each conductor. Test to be recorded & submitted.

2. Test Voltages: Megger instrument shall be 1000 volts DC applied for one minute.

3. Acceptable Test Results: Insulation resistance between phase conductors and any phase conductor to ground shall be not less than 2 megohms for connected conductors and 100 megohms for disconnected conductors.

B. Motor Control Centers and Panelboards

1. Equipment shall be tested for continuity, freedom from short circuits, and grounds and meggered to assure adequate resistances.

2. Test Voltages: Megger instrument shall be 1,000 volts DC for equipment rated 380 volts and 500 volts DC for equipment rated 220 volts, applied for one minute.

3. Acceptable Test Results: Insulation resistance phase and any phase to ground shall be not less than 100 megohms for equipment rated 380 volts and 25 megohms for equipment rated 220 volts.

C. Switchboards

1. Test electrical and mechanical interlock systems for proper operation and sequencing .

2. Test ground connections as specified under "earthing System."

3. Perform ratio and polarity tests on instrument current and potential transformers.

4. Perform insulation resistance tests on each bus section, phase to phase and phase to ground as specified under "Motor Control Centers (MCC) & (MSPs) (EMSPs) and all Panelboards." Prior to performing insulation resistance tests on buswork, isolate the buswork by racking out or opening circuit breakers and disconnects, short circuit and ground current transformer secondaires, remove potential transformer primary fuses and assure grounding of the enclosure.

5. Perfrom control wiring performance test using the approved manufacturer's elementary diagrams.

6. For selective switchboard and switchgear arrangements, verify proper phasing between the line and load stabs of the tie breaker cubicle busses using hot-phase hot-stick techniques, A-A, B-B, C-C.

7. Test disconnect switches as specified under "Circuit and Motor Disconnects."

8. Perform an insulation resistance test at 1000 volts DC on each circuit breaker for one (1) minute from pole-to-pole and from each pole-to-ground with breaker closed and across open contacts of each phase. Insulation resistance shall not be less than 100 megohms.

9. Set, calibrate and adjust protective device setting of each circuit breaker in accordance with the approved coordination study using secondary current injection.

10. Tests of relays associated with the distribution system shall include the following:

    a. Check equipment ground and assure continuity of connections.

    b. Remove blocking used for shipment.

    c. Check overcurrent and undervoltage relays for proper current and voltage range. Adjust relays in accordance with the approved coordination study.

    d. Check magnet coil for proper operating voltage.

    e. Clean contacts and magnetic surfaces where necessary.

    f. Check air gap between moving and stationary magnets with manufacturer's clearances.

    g. Check auxiliary contacts for correct arrangement with coil de-energized, i.e., normally open or normally closed.

    h. Check fuses for proper rating.

i. Check connectors for tightness.

j. With loads disconnected, energize control circuits and test for correct functioning.

k. For timing relays, adjust the timing cycle for proper equipment operation.

11. Control and instrument switch test shall include the following:

a. Inspect contacts and shunts, cleaning contacts if required.

b. Operate switch and note that design function are performed in proper sequence.

12. Ammeters shall be tested as follows:

a. Check connections from current transformer for AC shunts for DC to ammeters.

b. Check ammeter scale with current transformer ratio for AC and shunt millivolt rating for DC.

c. Set pointer on zero scale with no load.

13. Power factor and VAR meter tests shall include checking polarities of instrument transformers and connecting so lagging current will be to right of center.

14. Voltmeter tests shall include the following:

a. Check voltmeter scale with potential transformer ratio.

b. Set pointer on zero scale with no voltage.

c. Check voltmeter reading with test voltmeter when energized.

15. Wattmeter and watthour meter tests shall include the following:

a. Check with current transformer and potential transformers ratio.

b. Set wattmeter pointer on zero scale with no load.

c. Check rotation on watthour meter.

16. Tests of instrument transformers shall include the following:

a. Physically check polarity mark orientation on CTs and PTs with three line diagram on the plans and with manufacturer's drawings.

b. Check CT and PT polarity makings.

17. Electrical controls shall be tested by trial operation of control equipment after wiring is completed to see that each interlock and control function operates according to the manufacturer's operating instructions.

18. All nuts to be tightened according to devices manufacturer for torque levels. All nuts to be marked and rechecked on site. Torque level for each nut size & breaker to be recorded & submitted.

D. Motors

1. Motors shall be tested for freedom from short circuits and grounds meggered to assure adequate resistances.

2. Test Voltages: Megger instrument shall be 2,500 volts DC for testing 4,000 volt motors, 1,000 volts DC for testing 460 volt motors and 500 volts DC for testing 200 volt motors, applied for one minute.

3. Acceptable Test Results: Insulation resistance phase to ground shall be not less than 100 megohms for 4,000 volt motors, 20 megohms for 460 and 200 volt 3-phase motors and 5 megohms for 115 volt single phase motors.

4. Apply voltage momentarily and check each motors for correct direction of rotation. Correct if necessary.

5. Measure full load current reading of each motor and verify that the correct size heater elements have been provided for each starter overload relay. Where current flow exceeds the motor's nameplate value, install a "DO NOT OPERATE" tag, advise the Engineer and notify the Contractor to immediately correct the condition. If power factor correction capacitors are connected on the load side of the overload heaters, include the capacitive reactances in determining the proper overload heater size.

6. Submit a tabulation of each motor indicating the equipment identification, motor horsepower, voltage, measured full load current and heater rating and manufacturer's catalog number.

E. Grounding System

1. General

a. Tests on individual ground rods shall be performed with each rod isolated from each other and the grounding system.

b. Tests on the grounding system shall be made after installation and interconnection of the ground system elements including individual ground rods, ground grid cables, connections to structural steel, reinforcing bars, incoming water piping, ground busses on walls and within equipment, etc.

2. Tests of Individual Ground Rods

a. Measure the resistance to earth of each individual ground rod using a Biddle Co. ground tester or two auxiliary ground rods as described in IEEE Standard 550 paragraph 3.4.2 using an alternating test current. Locate the auxiliary rods at sufficient distance from the rod under tests to insure that the regions in which their resistances are localized do not overlap. Calculated resistances to earth shall not exceed 25 ohms.

b. If the resistance is greater than 25 ohms, it shall be reduced by lengthening the rod or driving additional rods with a minimum separation of 3 meters and cadwelding the rods together until the resistance is less than 25 ohms.

3. Tests of the Grounding System: Test ground system for continuity by applying a low voltage DC source of current, capable of furnishing up to 100 amperes. The ground path using structural steel must conduct 100 amperes. Resistance as calculated from the current and voltage shall not exceed 5 ohms.

F. Circuit and Motor Disconnects: Upon completion of the installation of electrical disconnects, energize circuits and demonstrate capability and compliance with requirements. Except as otherwise indicated, do not test switches by operating them under load. However, demonstrate switch operation through six opening/closing cycles with circuit unloaded. Open each switch enclosure for inspection of interior, mechanical and electrical connections, fuse installation and for verification of type and rating of fuses installed. Correct deficiencies, then retest to demonstrate compliance. Remove and replace defective units with new units and retest.

G. Sockets

1. Upon completion of wire tests, check sockets for proper voltages and phasing, utilizing a receptacle tester for 120 volt 16 and 20 ampere devices and a voltmeter for other devices.

2. Test three phase sockets for proper phase rotation using a phase sequence meter.

3. Grounded sockets shall be tested for location and the effectiveness of the ground insert.

4. Test ground fault circuit interrupter sockets with both local and remote fault simulations in accordance with the manufacturer's recommendations.

H. Lighting Switches: Test lighting switches for correct operation with special emphasis on 3-and 4-way switches.

I. Lighting Fixtures: Verify proper operation of lighting fixtures.

J. Emergency Lighting Units - Battery Operated: After emergency lighting units have been installed and building circuits have been energized with the normal power source, apply and interrupt electrical energy to demonstrate proper operation. Remove and replace malfunctioning units with new units and proceed with retesting. Include the following tests:

1. Duration of supply.
2. Low battery voltage shutdown.
3. Normal transfer to battery source and retransfer to normal.
4. Low supply voltage transfer.

K. Control Circuits: Test control circuits for proper functioning and fail safe operation.

L. Fire Alarm System

1. Provide the services of a factory-authorized service representative to supervise the field system pretesting, testing, adjustment and programming.

2. Pretesting: Upon completing installation of the system, align and adjust the system and perform pretesting. Determine, through pretesting, the conformance of the system to the requirements of the drawings and specifications. Correct deficiencies by replacing malfunctioning or damaged items with new items and retest until satisfactory performance and conditions are achieved.

3. Testing

   a. Perform electrical and mechanical tests required by the equipment manufacturer's certification form. In addition, measure and adjust each of the ionization detectors to the maximum stable sensitivity setting. This shall be performed with the detector at its operational location and under normal operational environmental conditions in the area. Bench settings are not acceptable.

   b. The completed smoke detection system shall be tested to insure that it is operating properly. This test shall consist of exposing the installed units to a standard fire test. Failure of the devices to detect smoke shall be considered a failure of the system and detectors in that system shall be re-adjusted or replaced. Acceptance of the system shall also require a demonstration of the stability of the system. This shall be adequately demonstrated if the system operates for a ninety (90) day test period without any unwarranted alarms. Should an unwarranted alarm(s) occur, the Contractor shall readjust or replace the detector(s) and begin another ninety (90) day test period. The Contractor shall recheck the detectors using the fire test after each readjustment or replacement of detectors using the fire test after each readjustment or replacement of detectors. This test shall not start until the Employer has obtained beneficial use of the building under tests.

   c. Wiring shall be checked and tested to insure there are no grounds, opens or short circuits.

   d. A checkout report shall be prepared and submitted, one copy of which shall be registered with the equipment manufacturer. The report shall include, but not be limited to:

      1) A list of equipment installed and wired.
      2) Indication that equipment is properly installed and functions and conforms with these specifications.
      3) Test of individual zones as applicable.

4) Serial numbers, locations by zone and model number for each installed detector.
5) Voltage (sensitivity) settings for each ionization and photoelectric detector as measured in place with the HVAC system operating.
6) Response time on thermostats and flame detectors.
7) Technician's name, certificate number and date.

e. After completion of the tests and adjustments listed above, submit the following information to the Engineer:

1) "As-built" conduit layout diagrams including wire color code and/or number.
2) "As-built" wiring diagrams.
3) Detailed catalog data on installed system components.
4) Copy of the test report.

END OF SECTION

TABLE OF CONTENTS

SECTION 0I - GENERAL REQUIREMENTS

GENERAL

This section generally specifies administrative and procedure requirements regarding mechanical work.

All quantities listed in the B.O.Q. are following the design drawings and to be revised for any discrepancies since any variations should not be acceptable for any reason during the works.

The requirements of this Section do not supersede or take precedence over any provision of the General Conditions and should any discrepancy become apparent between these requirements and the General Conditions, the Contractor shall notify the Engineer, in writing, and the Engineer shall interpret and decide such matters in accordance with the applicable provisions of the General Conditions.

Extent of Work
The Contractor shall supply all labor, materials, equipment, tools, appurtenances, storage, services and temporary work, necessary to completely install, in accordance with these specifications and the drawings, the following mechanical installation in subject Project:

- Soil and waste drainage to public main.
- Rain water drainage.
- Cold, hot, drinking and irrigation water pumping and distribution system.
- Sanitary fixtures.
- Fire fighting system.
- Air conditioning system.
- Ventilation system.

Work, materials, equipment or services not specifically mentioned or implied in other clauses of these specifications or elsewhere, or indicated on the drawings but found necessary for the completion and perfect functioning of the installations must be included in the Contractor's price.
The work shall include also operation of the installations after completion and acceptance including maintenance and guarantee of the works as described hereinafter.
The work shall be designed and carried out in accordance with the contract drawings and specifications as well as the standards of the country of origin.

The following builder's work shall be considered as part of this work:

1. Concrete pads under equipments.
2. All Builder's work in connection with fixing supports, hangers, anchors, etc.
3. Cutting or forming all openings, mortar, chases, etc., in floors, walls and ceilings required for the installation and making good after.
4. Painting items of equipment and exposed supports.
5. Labeling.

Design Conditions
All air conditioning equipment capacities are based on the following conditions:

1. Outdoor temperature

In winter	5°C	Dry bulb temperature.
In summer	38°C	Dry bulb temperature.
In summer	28°C	Wet bulb.

2. Indoor temperature

In winter	21°C	Dry bulb temperature.

In summer	24°C	Dry bulb.
In summer	17°C	Wet bulb.

3. Noise criteria

   All equipments shall operate under all conditions of loads without sound or vibration transmission.

   Sound levels shall not exceed:
   - Offices, corridors and bedrooms: 35 DBA.
   - Technical rooms: 55 DBA (outside room).
   - Public areas: 40 DBA.

QUALITY ASSURANCE

Materials and equipment shall conform to the specifications specified herein and to applicable codes and requirements of local authorities having jurisdiction.

1. Mechanical equipment shall conform to ASHRAE Standard.
2. Reference Standards
   a. Provide materials and equipment listed by Underwriters' Laboratories, Inc.
   b. Comply with the latest applicable standards of the following:
      1. “DIN” standard Deutsche Norman.
      2. ASHRAE - American Society of Heating, Refrigerating, and Air Conditioning Engineers.
      3. ASTM - American Society of Testing Materials.
      4. S.M.A.C.N.A. sheet Metal and air-conditioning contractors national association.
      5. National plumbing code.
      6. N.F.P.A. National fire protection codes related to similar building.
3. Site Engineers in charge shall have a good experience for similar project installation and follow up.

SUBMITTALS

Definitions: The required submittals of this division, in addition to the definitions of the General Conditions, and elsewhere in the contract documents, are further categorized for convenience as follows:

Product data shall include manufacturer's latest standard printed literature such as manufacturer's installation instructions, catalog cuts, color charts, roughing diagrams, wiring diagrams and performance curves on materials, equipment and systems for this project. Product data shall include references to applicable specification section and item number. Product data shall be provided in addition to the required shop drawing submittals.

Shop drawings shall submitted to Engineer for Approval as described hereinafter.

Samples shall include physical examples of materials in complete units for visual inspection. Samples shall indicate applicable specification section number and item numbers within that section.

DISCREPANCIES AND OMISSIONS

It is the responsibility of the Contractor, to inform the Engineer of any discrepancies in the drawings and specifications before signing the Contract, default of which will make him responsible for any errors or omissions in the drawings and specifications even though these have been approved by the Engineer.

All costs incurred by any changes or alterations necessitated by any errors or omissions shall be on the Contractor's own expense without having the right to ask the employer for any indemnity.

ENGINEER'S DRAWINGS

The Engineer's drawings are generally diagrammatic and include general layouts and typical details of the various systems to be installed. No deviations from the drawings shall be made without receipt of prior written approval from the Engineer.
The drawings shall not be scaled. The Contractor shall base all measurements both horizontal and vertical from established bench marks. All work shall agree with these established lines and levels. All measurements shall be verified on Site and checked as to correctness of same as related to the work.
The Contractor shall check all the Architectural, Structural and Electrical drawings in laying out work for verifying the adequacy of space in which work will be installed. Maximum headroom and space conditions shall be maintained at all points. Where headroom or space conditions appear inadequate the Engineer shall be notified before proceeding with installation.

SHOP AND INSTALLATION DRAWINGS

Prior to starting the work the Contractor shall submit to the Engineer for approval detailed shop and installation drawings showing to scale dimensions of equipment, pipes, etc. in plan and elevation with clearances and relation of same to the space assigned.
Where the work will be installed in close proximity to, or will interfere with the work of other trades, the Contractor shall coordinate space conditions to make a satisfactory adjustment. The Contractor shall prepare composite installation drawings and sections to a suitable scale of not less than 1/50, clearly showing how work will be installed in relation with work of other trades.
Prior to submissions of the drawings, the Contractor shall submit lists of all equipment and materials with the names of proposed manufactures. Lists shall show submission dates. The drawings will not be accepted prior to submission of such lists. Drawings of interrelated items shall be submitted at approximately the same time.
Drawings of equipment and material shall include detailed manufacturer's drawings, cuts of catalogues and descriptive literature, showing specifications, type, performance characteristics, construction, component parts, dimensions, size, arrangement, operating clearances, capacity, electrical characteristics, power requirements, motor, drive and testing information.
Catalogues, pamphlets or manufacturers' drawings submitted for approval shall be clearly marked in ink for proper identification of the item being proposed.
Deviations from the specifications and the drawings shall be indicated clearly with the reason for each deviation.

All submissions for approval shall be furnished in three copies and submitted sufficiently in advance of requirements to allow the Engineer ample time for checking and approving. Failure of the Contractor to submit the drawing in ample advance time shall not entitle him to an extension of contract time, and no claim for extension by reason of such default will be allowed.

No equipment or material shall be purchased, delivered to the Site or installed until the contractor has in his possession the approved drawings for the particular equipment or material.
Approval rendered on drawings shall not relieve the Contractor from his responsibility to provide equipment and material to meet the performance and quality standards as indicated on the drawings and as described in the specification or be of physical size to fit the space assigned for it.
Material not covered by drawings such as pipe, fitting and incidentals shall be submitted for approval in letter form giving ratings and names of manufacturers.
During the progress of the work drawings shall be submitted as required by the Engineer and as specified elsewhere in this specification. These drawings shall comprise but not necessarily be limited to concrete bases for equipment with location of anchor bolts, manufacturers'

certified installation drawings and instructions, certified performance characteristics of equipment, wiring diagrams of motor controllers and control systems, etc.
Where required by the Engineer the Contractor shall submit for approval samples of material to be used and workmanship proposed. The Contractor shall not use material or workmanship that does not correspond to the approved samples.

COORDINATION WITH OTHER TRADES

The Contractor shall plan and coordinate the work with all other trades in advance of requirements and shall provide all necessary resources to ensure compliance with the construction program.
The Contractor shall coordinate the space requirements of all other trades involved and shall be responsible for the sufficiency of the size of shafts and chases and the adequate clearance in double partitions, hung ceilings, etc. for the proper installation of the work.
The Contractor shall give full cooperation to all other trades to permit the work of the trades to be installed satisfactorily and with the least possible interference or delay.
The Contractor shall furnish to other trades, as required, all necessary templates, patterns, setting plans and shop details for the proper installation and coordination of adjacent work.
The Contractor shall undertake to make, without extra charge, minor changes and modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work.
Any extra cost incurred by lack of coordination on the part of the Contractor shall be at his own expense.

RECORD DRAWINGS

The Contractor shall submit to the Engineer for record a complete set of as-built drawings and electrical wiring diagrams, in tracing or other reproducible form, reflecting all the changes made from the original drawings during the progress of the work. The drawings and electrical wiring diagrams shall show all labeled equipment, valves, controls, instruments and electrical devices.

INSTRUCTION MANUALS AND SPARE PARTS LISTS

The Contractor shall furnish four copies of an instruction manual bound in booklet form containing the following information :
Brief description of every system and equipment with basic operating features.
Descriptive literature of all equipment and components with manufacturer's name, model number, capacity rating and operating characteristic.

Service manual for every major piece of equipment giving operating and maintenance instructions, starting and shutdown instructions, lubrication instructions and possible breakdown and repairs. The service manual shall be prepared specially by the manufacturer for the particular equipment and shall include preventive maintenance schedule.
Manufacturer's list of general spare parts for every piece of equipment with unit prices.
Manufacturer's list of recommended spare parts for one year of operation for every piece of equipment with unit prices.
Detailed and simplified one line, color coded flow diagram of every system with tag number, location and function of each valve and instrument.

The instruction manual shall be submitted in draft form to the Engineer for his review and approval as to the fulfillment of the specified requirements prior to final issue.
The instruction manual shall be submitted to the Engineer at least four weeks in advance of the complete date of the system to be available for the final inspection prior to acceptance of the respective systems.

Extra of above mentioned booklet, contractor shall supply during the defect liability period all the spare parks necessary for the normal running of equipments with the special tools where necessary.

Training to be done by contractor is required during execution, commissioning, testing and warranty period for the operation testing and maintenance of all systems.

EQUIPMENT AND MATERIAL QUALITY WORKMANSHIP

All equipment and material provided by the Contractor shall be new, free from defects and of the same type, standard and quality as set forth in the specification.
Equipment and material of similar application shall be of the same manufacturer unless otherwise specified.
All workmanship shall be of the highest standard of the industry, of accepted engineering practice and to the entire satisfaction of the Engineer. Poor workmanship shall be rejected and the work reinstalled when, in the judgment of the Engineer, the workmanship is not of the highest quality.

SUBSTITUTION OF EQUIPMENT AND MATERIAL

Reference in the drawings and specifications to any equipment or material by name, make or catalogue number, as well as any list of approved manufacturers, shall be interpreted as establishing a standard of quality and performance and shall not in any way be construed as an intention to eliminate the products of other manufacturers and suppliers having approved equivalent products.
Approval of a manufacturer does not necessarily constitute approval of his equipment as equal to those specified. After award of Contract and before start of construction the Contractor shall submit for the approval of the Engineer a complete summary of proposed equivalent to be furnished indicating service, manufacturer, figure number, type and pressure rating.
The Tender shall be based on the trade name and catalogue reference named in the specification and products of the approved manufacturers. Should the Contractor wish to use any equipment, material or products other than those specified he should so state as an alternative to the Tender, naming the proposed substitutions and indicating what difference, if any, will be made to the Contract Price and detailing all differences entailed by the substitution.
At all times the Engineer shall be the only judge of equality between the proposed alternative and the item specified. No alternative shall be implemented without the written approval of the Engineer.

Where the Contractor proposes to use equipment other than that specified or indicated which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the works, all such redesign, new drawings and detailing required shall be prepared by the Contractor at his own expense. All additional costs resulting from such substitution if approved by the Engineer in writing, shall be paid by the Contractor.

Where such approved substitution requires a different quantity or arrangement of piping, wiring, conduit and equipment from that specified or shown on the drawings the Contractor shall provide all such piping, structural supports, insulation, controllers, motors, starters, electrical wiring and conduits and any other additional equipment required by the system, at no additional cost to the Employer.

PROTECTION

The Contractor shall order all equipment from the manufacturer specifying adequate packing for export at the factory to avoid damage during shipment to the Site.

The Contractor shall be responsible for safe storage and the adequate protection of all material and equipment until finally installed, tested and accepted.
He shall protect work against theft, injury or damage and shall carefully store material and equipment received on Site in their original crates or containers until they are installed. This responsibility shall embrace any delay pending final testing of systems and equipment due to any condition.
The Contractor shall close open ends of work with temporary covers or plugs during construction and storage to prevent entry of obstructing material.
The Contractor shall coordinate the protection of the work of all trades and shall be liable for any damage sustained to other trades resulting from his work.
If any equipment is damaged during shipment or before it is tested and accepted, the Contractor shall replace or repair the equipment, depending on the extent of damage and as determined and decided by the Engineer, on the Contractor's own account and without additional cost to the Employer.

ACCESSIBILITY

Contractor shall be responsible for determining in advance of purchase that equipment and materials proposed for installation shall fit into the confines indicated areas, allowing adequate space for maintenance.
All work shall be installed so as to be readily accessible for operation, maintenance and repair. Deviations from the drawings may be made to accomplish this, after the written approval of the Engineer.

ACCESS DOORS

The Contractor shall arrange for access doors and frames to be provided for easy access to concealed equipment, controls, valves, traps, vents, drains, cleanout and other devices that require periodic operation, inspection or maintenance.
However, the dimensions and locations of access doors shall be the responsibility of the Contractor and shall have the approval of the engineer before the work is installed.
Requirements of access doors shall be submitted in sufficient advance time to be installed in the normal course of the work.
The Contractor shall be responsible for the correct identification of access doors approved by the Engineer.

NAMEPLATES

Each piece of equipment provided shall carry, a certified nameplate on which shall be printed or stamped clearly the name and address of the manufacturer, the equipment model number, serial number, date of manufacture, electrical characteristics, performance ratting or duty, pressure, temperature or other limitations and all other pertinent data as deemed necessary by the manufacturer for any future reference to the equipment.

LABELING

The Contractor shall label and identify all equipment, instruments, controls, electrical devices, valves, etc. as to duty, service or function.
Labels on equipment shall be of laminated bakelite with black surface and white core, with incised lettering nomenclature written in English.
Labels shall be attached to equipment, instruments, controls, electrical devices, etc. or to adjacent permanent surfaces, in an approved permanent manner.
The Contractor shall submit to the Engineer for his approval prior to installation a schedule of all equipment and devices to be labeled and the suggest nomenclature.

Controls and electrical devices shall be labeled to indicate clearly which equipment they control.
Refer to electrical specifications for cables and control wires labeling.

GUARANTEE

The Contractor shall guarantee that the materials and workmanship of the works installed by him under these specifications are first-class in every respect and that he will make good any defect, not due to ordinary wear and tear or improper use or care, which may develop within at least two years from date of completion.

SECTION 02 - PIPES AND FITTINGS

GENERAL

Provide labor, materials, equipment and services, and perform operations required for complete installation of Piping and Fittings and related work as indicated on the drawings and specified herein.

Work Included: The work shall include, but not be limited to, the following:
1. Galvanized welded steel pipes and fittings to DIN 2440 for domestic cold and drinking water at roof and in technical rooms.
2. Polypropylene pipes and fittings to DIN 8077, 8078, PN20 for cold, hot and drinking water inside apartments and in shafts.
3. Black seamless steel pipes and fittings for fire fighting (schedule 40).
4. Black seamless steel pipes and fittings for chilled water and for fuel oil (schedule 40).
5. U PVC drainage pipes DIN 8061, DIN 19531 and 19534 for toilet drainage, vent and rain water (sound proof, 3 layers pipes in shafts adjacent to occupied spaces).
6. PVC pressure pipe DIN 19532 for sewage water pumping and for A/C drainage.
7. Copper pipes for A/C refrigerant.

QUALITY ASSURANCE

Materials shall conform to the latest edition of reference specifications and industry standards specified herein and applicable, and to pertinent codes and requirements of local authorities having jurisdiction.

Manufacturer's Qualifications: Firms regularly engaged in manufacture of pipes and pipe fittings of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

SUBMITTALS

Product Data
1. Submit copies of manufacturer’s lasted published literature for each type of pipe and pipe fitting specified herein for approval. Obtain approval before ordering materials.
2. Data shall include piping schedule showing manufacturer, pipe or tube weight, fitting type, and joint type for each piping system.

Certificates: Submit certificates attesting to compliance with these specifications to Engineer for approval. Obtain approval prior to ordering materials.

Maintenance Data: Submit maintenance data and parts lists for each type of mechanical fitting. Include this data, product data, and certifications in maintenance manual, as approved.

DELIVERY, STORAGE AND HANDLING

Except for concrete, corrugated metal, hub-and-spigot, clay, and similar units of pipe, provide factory-applied plastic end caps on each length of pipe and tube. Maintain end caps through shipping, storage and handling as required to prevent pipe-end damage and eliminate dirt and moisture from inside of pipe and tube.

Where possible, store pipe and tube inside; protect from weather. Where necessary to store outside, elevate above grade and enclose with durable, waterproof wrapping.

Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

INSTALLATION

PIPELINE SLOPES

Horizontal pipelines shall have the following slopes, unless otherwise indicated by the Engineer.

- All water supply and water distribution: 0.2% to 0.5%.
- Soil, waste and rain water drains: 1% to 2%.

GENERAL REQUIREMENTS FOR PIPE INSTALLATION

- All pipes shall be installed in straight parallel lines.
- Pipes shall be spaced to permit their installation, maintenance and insulation.
- Concealed pipes shall be installed in such a way as to permit their maintenance and inspection.
- All pipes shall be so installed as to ensure easy and even flow of the water to and from all equipment and fixtures.
- Pipelines shall be installed in a manner to allow for easy air escape and system draining. It shall be executed to obtain this naturally by gravity.
- However, where this cannot be met, provision should be made to ensure quick and positive drainage and noiseless air discharge.
- Automatic air vents shall be installed at all points in the pipelines where air gaps can form and drain valves shall be installed at all low points and at the lowest point of each riser leg and wherever required to permit complete drainage of all lines.
- Provide dielectric unions wherever copper pipes connected to ferrous pipes.
- Drain pipes shall be joined together in a manner satisfying perfect running condition.
- Vent pipes shall not be trapped and shall be graded to drip back to waste or soil line.
- All vents for waste and soil stacks shall extend above the highest point of the roof and shall be equipped with a vent head and cap as specified.
- Free discharge outlets of rain water drains shall be done in 45° or 90° combination of bends as found necessary by the Engineer.
- Sleeves shall be supplied and installed wherever pipes cross slabs, walls, partitions, etc.
- Clean-outs shall be placed at all changes in direction and every 15 meters for the straight run whether shown on the drawings or not.

CONDITIONS FOR PIPE ASSEMBLY

- Before installation, all pipes shall be cleaned of all foreign matter and shall be reamed smooth after cutting. All trenches shall be cleaned up.
- Pipes shall be carefully cut by hacksaw or by special pipe cutting machine.
- Steel pipe ends shall be cleaned and smoothed on edge to avoid all roughness and unevenness before welding or threading.
- Threading shall be done for the total length of joint or accessory with a reliable threading machine.
- All changes in pipe size shall be made with fittings. Excentric reducing fittings shall be used to prevent pocketing.
- Change in direction of piping shall be made with long radius fittings.
- The exposed ends of incomplete or unconnected work shall be plugged. Plugging shall be perfect with gate valves, counter flange plugs or thread plugs.

- All piping subject to expansion and contraction shall be installed with expansion bends, swing joints made up of fittings or other approved methods or devices. Branch lines from lines subject to expansion and contraction shall have a swing joint at the point of

connection with the main. Expansion joints shall be installed even if not shown on the drawings or count for in the bill of quantities.

JOINTING OF GALVANIZED WELDED STEEL PIPES

Galvanized welded steel pipes shall be jointed with screwed socket joints of adequate materials. Care must be taken to remove any burr from the end of pipes after threading.
All jointing must be done with Teflon.
Any threads exposed after jointing should be painted, or in the case of underground piping, thickly coated with bituminous or other suitable composition to prevent corrosion as DENSO TAPE band or approved equivalent.

JOINTING OF POLYPROPYLENE PIPES

Polypropylene pipes shall be jointed by electric welding.

JOINTING OF BLACK STEEL PIPES

Black steel pipes shall be jointed by threading until 2” and smaller and by welding for larger diameter. Welding shall be executed by a qualified welder with welding certificate and at least 10 years experience in pipe fitting procedure.

JOINTING OF CAST IRON PIPES

Cast iron pipes shall be jointed by ring hub similar to “Pont à Mousson” S.M.U..
Jointing must be done according to the manufacturer's recommendations and only by a skilled experienced plumber.

JOINTING U PVC PIPES

U PVC pipes inside toilet and in walls shall be sovent joint DIN 19531, and pipes in shafts, underground or under ceiling shall be rubber joint DIN 19534.

PIPE ACCESSORIES AND FITTINGS

GENERAL

The accessories shall be of the same standard as the pipes on which they are fitted, they shall be flanged, threaded or welded depending on the type and the diameter of the pipe and the location in which the pipes are installed.

UNIONS AND FLANGES

Unions and flanges shall be installed at all equipment inlets and outlets, at all valve inlets or outlets, on all pipe branches and in general, at every 15 meters of pipe run.
Unions shall be used on all screwed pipes and shall be of the same quality and service.

PIPE SLEEVES

Pipe sleeves shall be supplied and installed wherever pipes cross slabs, walls partitions, ceilings, floors, etc.
For pipe sleeves passing from a fire zone compartment to another, foam should be used having the same fire rating as fire zone compartment.
Sleeves shall be cut of galvanized steel pipe of approved weight, having an internal diameter of not less than 1cm larger than the bare sleeved pipe or the insulated sleeved pipe depending on the particular condition.
Sleeves passing through wall partitions and ceiling shall terminate flush with finished wall or ceiling surface.

Sleeves passing through floor shall extend 5cm above the finished floor level.
Sleeves passing through roof shall extend 15cm above the finished surface and shall be provided with a 1mm lead flashing to prevent roof water penetration.
All gaps shall be plugged with a non-flowing, plastic and waterproof mastic paste.

STRAINERS

Strainers shall be of Y-type, bronze construction with stainless steel screen, designed for servicing without being dismantled from the pipe and suitable for 16 bar working pressure.
Strainers shall be installed at the inlets of pumps as shown on drawings.

EXPANSION JOINTS

Expansion joints shall be of the rubber or stainless steel bellow type suitable for 16 bars working pressure. The connection shall be in accordance with the pipe material.
The type, number and location of the expansion joints shall be approved by the Engineer.

PIPE GUIDES

Pipe guides shall be used before or after expansion joints, the other side of the pipe being properly anchored. The guides shall be of a standard construction approved by the Engineer.

MANHOLE

1. Manhole Construction
   Manholes shall be constructed of class "B" concrete as shown on the drawings.
   The base (where required) shall be of pre-cast class "B" reinforced concrete.
   The shaft shall be constructed of poured reinforced concrete to suit the required depth.
   The top shall be of class "B" reinforced concrete. An opening suitable for the cover shall be left in the top around which the radial concrete blocks or concrete ring are built for proper adjustment of levels. Blocks concrete shall be fully bedded in mortar and the inside surface of joints finished flush and clean.
   The benching shall be formed in the bottom of manholes in class "B" concrete. "U" channels shall be formed with bottom flush with inside surfaces of pipes and sides extending the full height of the largest pipe and then sloped back at a minimum fall of 10%. The benching and channels shall be finished with 2 cm thick rendering composed of 1/2 cement/sand mortar, and surface hardened with two coats of sodium silicate solution brushed on. The finished diameter of channels shall be the same as the diameter of pipes entering or leaving the manhole.
   The paint for the manhole interior shall be coal tar epoxy resin.
   The external surfaces of manholes shall be coating with asphaltic composition material.
2. Covers and Frames
   Covers and frames shall be ductile iron and having the sizes shown on the drawings.
   Covers and frames shall be tested for 250 KN or 400 KN loads according to their locations.
   The covers and frames shall be painted inside and outside with coal tar containing not less than 25% epoxy.
3. Steel Ladders
   Steel ladders for deep manhole shall be mild steel, galvanized, fixed to side walls each 30cm pitch.

SECTION 03 - VALVES

GENERAL

Provide labor, materials, equipment and services, and perform operations required for complete installation of Valves and related work as indicated on the drawings and specified herein.

Work Included: The work shall include, but not be limited to, the following:

1. Types of valves specified in this section include the following:
    a. Gate Valves.
    b. Check Valves.
    c. Double regulating Valves.
    d. Float Valves.
    e. Cleaning faucets.
    f. Pressure reducing valves.

QUALITY ASSURANCE

Materials and work shall conform to the latest edition of reference specifications, industry standards listed below and specified herein and to applicable codes and requirements of local authorities having jurisdiction, whichever is more stringent.

Tests: Test valves in accordance with the appropriate section of the specification describing each system.

SUBMITTALS

Product Data: Submit copies of manufacturer's latest published literature for materials and equipment specified herein for approval; obtain approval before ordering materials.

DELIVERY, STORAGE AND HANDLING

Exercise proper care in the handling of work so as not to injure the finished surfaces, and take proper precautions to protect the work from damage after it is in place.

MATERIAL

Provide valves of same type by one manufacturer.

Provide valves with manufacturer's name (or trademark) and pressure rating clearly marked on valve body.

All valves shall be designed for a working pressure of 16 bars.
Valves shall be of the same diameter as the pipe served.
A union shall be used with all gate, check and float valves.

GATE VALVES

Gate valves shall be designed for working under pressure with valves opened or closed.
Valves shall be of the wedge disc type and shall permit straight line flow and complete shut-off.
The screwed valves shall have joints with B.S. pipe threads. Flanged valves shall have the bolt holes to match the equipment or pipes on which they are installed.
Gate valves 2” and smaller shall be all bronze, with screwed ends, union bonnet, wedge disc.
Gate valves 2 1/2” and larger shall be cast-iron, bolted bonnet flanged ends, bronze wedge disc faces and seats.

CHECK VALVES

Check valves shall be used on the discharge side of pumps and whenever shown on the drawings or requested by the Engineer.
Check vales 2” and smaller shall be bronze with screwed ends, screwed cap swing type.
Check valves 2 1/2” and larger shall be cast-iron with flanged ends, bolted cap swing type.

DOUBLE REGULATING VALVES

Double regulating valve shall be installed where shown on drawings for flow regulation .
Double regulating valve 2” and smaller shall be all bronze with screwed end.
Double regulating valve 2 1/2” and larger shall be cast iron body, flanged with renewable bronze seat ring and metal disk.
Balancing procedure to follow supplier instructions.

FLOAT VALVES

Float valves shall be of all bronze construction including levers and arms, with PVC float and suitable for a cold water working pressure of 16 bars. Float valves shall have screwed inlets.
Float valves shall be of the full bore, equilibrium ball type, designed to close tight against maximum pressure when half submerged. They shall have renewable synthetic rubber valve discs and balancing piston buckets.

CLEANING FAUCETS

All valves shall be of the ball gate valves type.

PRESSURE REDUCING VALVES

Pressure reducing, or regulating valves shall be installed for reducing pressure to a steady outlet pressure regardless of flow or inlet pressure.
Pressure reducing and pressure regulating valves, to be bronze body for small sizes (2” and less) and cast iron for big sizes (21/2” and more).
Pressure regulating valves to be installed with upstream, downstream and bypass gate valves for maintenance requirements.

SECTION 04 - PIPE, FITTINGS AND VALVES - APPLICATION

GENERAL

Provide labor, materials, equipment and services, and perform operations required for complete installation of pipe, fittings and valves application and related work as indicated on the drawings and specified herein.

QUALITY ASSURANCE

Materials and work shall conform to the latest edition of reference specifications and industry standards specified herein and to applicable codes and requirements of local authorities having jurisdiction, whichever is more stringent.

Fittings shall have the same wall thickness and schedule as the pipe.

Pressure rating of fittings and valves shall exceed highest specified service pressure of the system in which installed.

Materials, fittings and valves of any one type shall be from one manufacturer.

APPLICATIONS

Examine conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

Examine the Contract Drawings and specifications in order to insure the completeness of the work required under this Section.

Verify measurements and dimensions and check all capacities at the job site and cooperate in the coordination and scheduling of the work of this Section with the work of related trades, so as not to delay job progress.

PIPES AND FITTINGS INSTALLATION

1. Install pipes and pipe fittings, in accordance with recognized industry practices, which will achieve permanently leakproof piping systems capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes by use of reducing fittings.
2. Locate piping runs, except as otherwise indicated, vertically and horizontally; pitch to drain and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, columns and other structural and permanent enclosure elements of building; limit clearance to 1/2 inch where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any.
3. Provide domestic water connections to equipment requiring them from valved outlets dedicated for this service.
4. Cap or plug open ended valves for future connections, drains and vents.
5. Electrical Equipment Spaces: Do not run piping through transformer vaults and other electrical or electronic equipment spaces and enclosures unless unavoidable. Install drip pan under piping that must be run through electrical spaces.
6. Pipe Joints - Mechanical

a. Make mechanical joints in strict accordance with the recommendation of the manufacturer using jointing material provided with the pipe.
b. Clean jointing surfaces thoroughly by wire brushing before assembly. Center spigot in bell, apply soapy water and slip the gasket over the spigot and into the bell.

7. Arrangement and Alignment
   a. Install piping in straight parallel lines.
   b. Install pipe groups for plumbing and HVAC parallel with pipe of other trades.
   c. Space pipe supports, arrange reducers and pitch piping to allow air to be vented to system high points and to allow the system to be drained at the low points. Provide drain valves at the base of each riser, at low points and wherever required to permit complete draining of lines.
   d. Provide automatic air vents at high points of water lines and wherever required to allow air to vent from system. Each vent shall have a drain line piped to nearest indirect waste.
   e. Configure piping with loops, swing joints, anchors, base elbows, etc. as required and approved to assure proper expansion and contraction of elements of the piping system without damage to equipment, structure, or piping.
   f. Provide runouts, risers and connections to coils, convectors and fan-coil units with double swing joint connections to withstand expansion and contraction.
   g. Pipe and fittings furnished as part of factory fabricated equipment are specified as part of equipment assembly in other sections.

8. Fittings - General
   a. Make changes in size and direction of piping with fittings. Do not use miter fittings, face or flush bushings, close nipples or street elbows.
   b. Make branch connections with tees as directed by the Engineer.
   c. Use eccentric reducing fittings or eccentric reducing couplings where required by the contract documents or where required to prevent pocketing of liquid or non-condensable.
   d. Fittings shall be factory manufactured. Shop or field fabricated fittings are not acceptable.
   e. A nipple shall be considered any piece of pipe 6 inches in length or less. Threaded nipples shall be extra heavy. Do not use close nipples.
   f. Screw threads shall be cut clean and true; make screw joints tight without caulking. Caulking is not permitted; a non-hardening lubricant is acceptable. Bushings shall not be used. Make reductions, otherwise causing objectionable water or air pockets, with eccentric reducers or eccentric fittings. Ream out pipe after cutting to remove burrs.
9. Connections to Equipment and Control Valves
   a. Provide flanges or unions at final connections to equipment and control valves to facilitate dismantling. Offset connections to permit removal or servicing of equipment being serviced without dismantling the piping.
   b. Provide automatic valves with a gate valve and a strainer on the inlet side.
   c. Install supply piping to coils, pumps and other equipment including gate valves and strainers at line size. Make reductions in size only at the inlet to the control valve or pump. Install the outlet piping from the control valve at the full size of the tapping in the equipment served.
   d. Install piping and dirt pockets or mud legs in return lines the full size of the tapping in the equipment served. Install piping, check valves and strainers in these return lines beyond the dirt pockets the size of the tapping in the trap.

Valves installations

1. General Requirements
   a. Install valves with handwheels horizontally or vertically upward unless specifically shown otherwise.

b. Install valves in accessible locations to facilitate easy removal for repair or replacement.
c. Connect threaded end valves installed in copper tubing lines where joints are ordinarily soldered or brazed to the tubing by means of adapters screwed into the valves and soldered or brazed into the tubing.
d. Valves shall be full line size, unless otherwise indicated.
e. Double regulating, globe and check valve discs shall be in accordance with manufacturer's recommendations for the service.
f. Valves shall be capable of being repackaged while wide open and operating at their rated pressure.
g. Where angle valves are indicated or required, use equivalent of specified globe type.
h. Provide 5 operating wrenches for each type of valve not equipped with handwheels.

2. Except as otherwise indicated, install valves where required for proper operation of piping and equipment, including valves in branch lines where necessary to isolate sections of piping. Locate valves to be accessible and so that separate support can be provided when necessary. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.
3. Insulation: Where insulation is indicated, install extended-stem valves; arrange in proper manner to receive insulation.
4. Selection of Valve Ends (Pipe Connections): Except as otherwise indicated, select and install valves with the following ends or types of pipe/tube connections:
   a. Tube Size 2 Inches and Smaller: Soldered-joint valves.
   b. Pipe Size 2 Inches and Smaller: One of the following, at Installer's option:
      1. Threaded valves
      2. Grooved-end valves
      3. Butt-welding valves
      4. Socket-welding valves
      5. Flanged valves
   c. Pipe Size 2-1/2 Inches and Larger: One of the following, at Contractor's option, as approved by Engineer:
      1. Socket-welding valves
      2. Flanged valves
      3. Mechanical joint end valves
   d. Valve System: Select and install valves with outside screw and yoke stems, except provide inside screw non-rising stem valves where headroom prevents full opening of valves. However non-rising stem shall not be accepted for fire fighting system.
   e. Installation of Check Valves
      1. Swing Check Valves: Install in horizontal position with hinge pin horizontally perpendicular to center line of pipe. Install for proper direction of flow.
      2. Wafer Check Valves: Install between 2 flanges in horizontal or vertical position; position for proper direction of flow.
      3. Lift Check Valve: Install in piping line with stem vertically upward; position for proper direction of flow.

FIELD QUALITY CONTROL

Material Tests and Identification

1. In addition to the tests required for specific systems, the manufacturer shall test or guarantee material specified prior to delivery.

2. Inspect materials for defects. Identify materials with factory applied permanent stampings or markings designating their conformance with specified requirements.

Hydrostatic Pressure Tests

1. Test piping including valves, fittings and joints at a pressure equal to at least 1-1/2 times the rated or system pressure, as indicated. Perform the test hydrostatically unless directed otherwise.
2. Blank off or remove elements such as traps, instruments, automatic valves, diaphragm valves, relief valves, pumps or any other equipment which may be damaged by test pressure. Open, but do not back seat, valves.
3. Fill the system with water and vent the system at high points to remove air.
4. Maintain the required test pressure for a sufficient length of time to enable complete inspection of joints and connections but no less than 4 hours.
5. Repair leaks or defects uncovered by the tests and retest the system.
6. After completion of tests, drain the system and blow out and clean it of rust and/or foreign matter. Clean strainers, valves and fittings of dirt, filings and debris.
7. Do not insulate or conceal piping until completion of tests and approval of the results.
8. Perform tests in the presence of, and to the satisfaction of, the Engineer.

Testing of Piping - General

1. Test piping, mains, and joints for leaks, before any piping is enclosed, insulated, or concealed in any way. Follow specific procedures, if given, in the other specification sections.
2. Refrigerant piping. Test for leaks with a halide torch. Recharge each system as necessary after testing.
3. Provide temporary equipment for testing, including pump and gauges. Test piping system before insulation is installed, wherever feasible, and remove control devices before testing. Test each natural section of each piping system independently, but do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for indicated pressure and time.
   a. Required minimum test period is 24 hours.
   b. Test runs at pressures listed except where fittings are lower Class or pressure rating.
   c. Test each piping system at 150 percent minimum of operating pressure indicated, but not less than 8 bars test pressure.
   d. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 5 percent of test pressure.
4. Repair piping system sections which fail required piping test by disassembly and reinstallation, using new materials to extent required to overcome leakage. Do not use chemicals, stop-leak compounds, mastics, or other temporary repair methods.
5. Drain test water from piping systems after testing and repair work has been completed.

CLEANING, FLUSHING, INSPECTING AND DISINFECTION

Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings, if any. Flush out piping systems with clean water before proceeding with required tests. Inspect each run of each system for completion of joints, supports and accessory items.

Disinfect water mains and water service piping in accordance with international codes.

Cleaning - Piping Systems

1. Plug open ends of piping, valves and equipment except when actual work is being performed, to minimize accumulation of dirt and debris.
2. After installation is complete, place temporary screens at connections to equipment and at automatic control valves where permanent strainers are not provided.

3. Prior to the performance of tests, flush out piping that is to receive a hydrostatic test with clean water. Blow out piping that is to be air or gas pressure tested with compressed air.
4. Remove dirt and debris collected at screens, strainers and other points from the system.
5. After hydrostatic testing, blow out fuel oil lines with compressed air until dry.
6. Where noted, flush out fuel oil pipe lines with clean oil after lines are dry.

Supplemental Cleaning - Water

1. After the piping system is installed, tested and flushed, completely clean the system to remove organic, rust and other foreign matter and provide protection of the metal surfaces in preparation for permanent water treatment.
2. Use a cleansing agent which will not in any way interact with any of the materials in the system to produce corrosion, form deposits, weaken, reduce the life or in any way have a detrimental effect on any system components.
3. Fill the system with clean water and add sufficient cleaning preparation to provide a concentration adequate to perform complete cleaning. Add the cleaning preparation at a point which will assure good mixing and complete dispersal throughout the system.
4. Provide temporary receivers or drums to accommodate any foam that may form.
5. Circulate the mixture of cleanser and water for a sufficient length of time to complete the cleaning.
6. Drain the system, flush with clean water, clean strainers and screens and refill the system.

Disinfection Water Systems

Disinfect new water systems prior to use whenever samples from the system show any contamination after making a bacteriological examination. Follow the following method:

1. Flush the pipe system with clean water until no dirty water appears at the outlets.
2. Fill the system or part thereof with a water-chlorine solution containing at least 50 ppm of chlorine and valve off the system or part thereof and allow to stand for 24 hours or, fill the system or part thereof with a water-chlorine solution containing at least 200 ppm of chlorine and allow to stand for 3 hours.
3. Following the prescribed standing time, flush the system with clean water until no excess chlorine remains in the water coming from the system.
4. Repeat the procedure if it is shown that contamination still persists in the system.

Valve Adjustment: After testing and putting piping systems into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks; replace valve if leak persists.

Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touchup paint.

SECTION 05 – DUCT WORK

GENERAL

Provide labor, materials, equipment and services, and perform operations required for complete installation of the Ductwork and Casings and related work as indicated on the drawings and specified herein.

Work Included: The work shall include, but not be limited to Duct work

QUALITY ASSURANCE

Materials shall conform to the latest edition of industry standards and reference specifications specified herein and to applicable codes and requirements of local authorities having jurisdiction, whichever is more stringent.

1. Fabrication and installation shall comply with Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA) construction and testing manuals, latest editions.
2. Applicable codes and regulations.
3. Duct sheets shall be galvanized G90 with zink coating of 275 g/m².

System Performance: The system has been designed for optimum performance. Any subsequent alterations to the design must be accompanied by a computer analysis or hand calculations showing that the proposed alterations will still provide the original design volume without increasing the system total pressure. Any unavoidable field changes to the original design (offsets, etc.) shall be reported to the Engineer so that accurate "as built" operating parameters may be established.

SUBMITTALS

Product Data: Submit manufacturer's technical product data, including performance data for each size and type of equipment schedule showing drawing designation, room location, number furnished, model number, size, and accessories furnished, and installation instructions.

Shop Drawings: Submit shop drawings indicating dimensions, layout, required clearances, capacities, and methods of assembly of components. Obtain approval of duct fabrication standards proposed before making any duct layout or fabricating any ductwork. Indicate deviations from specification requirements and document Contractor's fabrication standards with SMACNA standards.

Maintenance Data: Submit maintenance data and parts list for each type of air terminal including “troubleshooting" maintenance guide. Include this data, product data, shop drawings, and maintenance data in maintenance manual.

MATERIALS

General
Supply and install sheet metal ductwork for the air conditioning and the ventilating systems as shown on the drawings and as detailed below.

The Contractor shall check the building dimensions and the dimensions and positions of plant on site before the fabrication of ductwork are started. All seems, joints and connections to plant shall be made so as to reduce air leakage to a minimum. Internal roughness and obstructions

to airflow (other than dampers, vanes, etc.) will not be accepted. Sharp edges or corners on the outside of ductwork, flanges, supports, etc. will not be accepted. Any part of galvanized ductwork where the galvanizing is damaged during manufacture or erection shall be painted with two coats of aluminum, zinc rich or other corrosion resisting paint.

Duct thickness to be as follows:

LARGEST SIDE OF DUCT			SHEET METAL THICKNESS
0	-	30 cm	0.6 mm
31	-	75 cm	0.7 mm
76	-	150 cm	0.9 mm
151	-	220 cm	1.0 mm

Duct Work
Provide all ductwork, plenums, fittings and related sheet metal work shown, noted and/or specified for the air conditioning and ventilating systems.
Conform accurately to the layout indicated on the drawings, and construct to be straight and smooth on the inside with all joints neatly finished.
Securely anchored to the building construction in an approved manner, and installation to be completely free from vibration and pulsing under all operating conditions.
Contractor shall be fully responsible for all off-sets, up-slopes, down-slopes, etc. necessary to avoid conflict with lighting fixtures, sanitary piping, etc.
Bends and offsets shall have a minimum throat radius equal to the width of the duct. Where short radius elbows are indicated or are agreed by the Engineer as necessary due to site limitations the dimensions and internal vane(s) shall be in accordance with duct detail drawings.

Duct Support
Where cantilever brackets or other special forms of support are necessary, they shall be structurally strong enough to take the load and to transfer the load to the building structure.
Unless detailed otherwise ducts shall be supported at intervals that do not exceed :
- 120 cm for ducts with long side greater than 30 cm.
- 240 cm for ducts with long side less than 30 cm.

Flexible ducts or connections shall be supported at 1 meter centers.
No screws, bolts or other fittings for brackets or supports shall penetrate the air duct.

Duct Flexible Connection
Flexible Connection shall be provided on fan inlet and outlet connections. They shall be of the full cross sectional area of the matching fan inlet or outlet or duct section. The ends of the ducts or the duct and fan connection shall be in line.

Volume Control
Damper adjustment devices shall be so installed as to be fully concealed in rooms and spaces with finished ceilings bearings shall be Teflon or Nylon.
Dampers are not shown on drawings but they shall be installed wherever required by the engineer.

Duct Protection
The Contractor shall by means of polyethylene or similar sheeting protects all openings in ductwork during erection to prevent the collection of dust and dirt during the building construction.

He shall be responsible for removing all these sealers from the systems prior to the plan being commissioned.
He shall nevertheless be responsible for cleaning all ducts internally before the plant is commissioned, the provision of the seals being a precaution aimed at reducing the amount of cleaning necessary.

Duct Leak Test and Sealing
The Contractor, shall when the main fans are operable, test all flanged joints, access doors or panels, hand holes and test points with smoke test procedure. Any joints failing the test shall be remade.
Insulation shall not be applied until this test has been made.

Silencing and Acoustic
The Contractor shall be responsible for the quietness of the equipment in respect of vibration and sound transmission to the structure and occupied spaces.
Where it is necessary to provide silencing equipment, anti vibration inserts mountings and other acoustic devices, the Contractor shall include them in his tender.

Duct Lining – Internal Insulation
Where ducts are to be provided with internal absorbent linings to meet the Contractor's requirements in respect of silence, the Contractor shall provide non-inflammable resin bonded mats of glass fiber that have a strong film of PVC sheet on the air flow side. Such mats shall be secured to ducts with synthetic resin or other suitable adhesives and aluminum strips.

Volume Dampers – Duct Mounted
Supply and install all duct mounted volume dampers whenever shown on the drawings and as specified herein.
Each duct mounted volume damper shall be of galvanized steel construction, butterfly single blade type for ducts up to 15” deep, and multiple, opposed blade type for ducts deeper than 15”.
Maximum blade sized shall be 48’ x 10” and not less than 1.2 mm thick.
Multiple frame sections shall be used for dampers installed in ducts larger than 48”.

Fire Dampers
Supply and install fire dampers according to U.L.555 where shown on drawings and on ducts crossing the fire zone walls and slabs, (if required) as shown on drawings and as specified herein.
Fire dampers shall be constructed of 3mm thick black steel plate, with frames and blade so designed as to cause no obstruction to air flow when in the open position. Fire dampers shall be rated at least according to related fire wall rating. Fire dampers shall be installed without strain or distortion to any part and all moving parts shall move freely without building. Dampers shall be caulked tight around the frames which shall extend the full thickness of wall or floor in which they are installed.
Fire dampers shall be weighted so that they will close promptly when released regardless of pressure and direction of air flow. The damper blade shall be hung on zinc-coated steel hinges with loose fitting brass pins and bushings. It shall close tightly against angle stops and shall have retaining springs.
The damper blade shall be held open by a fusible link having a melting temperature of not higher than 75°C (167°F). An access door shall be provided in the duct for replacement of the fusible link.

INSTALLATION

Examine conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

Examine the Contract Drawings and specifications in order to insure the completeness of the work required under this Section. Provide supplementary parts necessary to complete duct work, though not specifically indicated or specified herein.

Verify measurements and dimensions at the job site and cooperate in the coordination and scheduling of the work of this section with the work of related trades, so as not to delay job progress.

Construct ductwork and casings in accordance with the specifications [and tables listed] in this Section and details as shown. Items not covered above shall be in accordance with the latest applicable standards of the Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA), as approved in the required shop drawing submissions.

Bracing and supports indicated are the minimum acceptable. Install additional bracing or supports to eliminate any distortion or vibration when the systems are operating or under tests.

Install ducts, casings and hangers plumb and level, with joints square and devoid of sharp edges.

Route ductwork to minimize directional changes and abrupt transitions.

Provide adequate space around ducts to assure proper support and to allow the installation of the insulation specified.

Install approved diverting vanes at branches which must be connected into the main duct without a neck. In general, size branch necks so that air velocity at neck is the same as that of main duct into which neck connects.

Provide flaring where pipes or structures must penetrate ducts. When flaring is longer than 2 feet maintain the original velocity. When flaring is shorter than 2 feet the velocity may be increased by not more than 10 percent.

Furnish approved test wells; make from a brass nipple welded into the duct or casing and a cap on the downstream side of each coil and fan. On low pressure systems and on the fan suction side of casings an instrument test hole with cap may be used in lieu of a welded brass nipple.

Provide turning vanes in elbows whose center line radius is less than 150 percent of the duct width or where indicated.

Where hanger rods for ducts, piping or equipment must pierce ducts, provide closure plates. Fit around the rod and rivet or weld to the duct; used in conjunction with approved duct sealing compound to make an airtight seal. In general, connect rods to additional duct bridging angles wherever possible so ducts do not have to be pierced.
Make connections between ductwork, including flexible connections, fittings and equipment with 15 degrees tapered transition fittings, whenever possible.

FIELD QUALITY CONTROL

Tests During Construction
During construction of the duct systems and before the application of insulation, one or more designated duct sections shall be tested (smoke test) for each Duct Construction Class and for each Leakage Class for each system as designated by and in accordance with the SMACNA"HVAC Air Duct Leakage Test Manual", including casings and flexible run outs in the

presence of the Engineer. The Engineer shall establish the sizes and locations of test sections. The designated duct section shall represent a minimum of 25% of each system. If any section has three (3) section failures, the entire system shall be tested.

The testing shall be performed by the Mechanical Subcontractor and supervised by Engineer familiar with testing procedures.

The size of the test section may vary from a complete supply or exhaust system to a portion of a system, depending on its complexity and size. The Engineer shall use Appendix F in the aforementioned SMACNA Manual as a guide in determining test section sizes and locations.

SECTION 06- SUPPORTS AND HANGERS

GENERAL

Provide labor, materials, equipment and services, and perform operations required for complete installation of supports and hangers, related to pipes, ducts and equipments and related work as indicated on the drawings and specified herein.
The work shall include hot dip galvanized hangers and supports for all applications

QUALITY ASSURANCE

Materials and work shall conform to the latest edition of reference specifications and industry standards listed below and specified herein and to applicable codes and requirements of local authorities having jurisdiction, whichever is more stringent.
Code Compliance: Comply with applicable H.V.A.C. and plumbing codes pertaining to product materials and installation of supports and anchors.

SUBMITTALS

Shop Drawings: Submit shop drawings for work specified herein for approval. Shop drawings shall show manufacturer's assembly-type shop drawings for each type of support and anchor, indicating dimensions, weights, required clearances, and methods of assembly or components.

Product Data
1. Submit copies of manufacturer's latest published literature for materials specified herein for approval; obtain approval before ordering materials.
2. Data shall include manufacturer's technical product data, including installation instructions for each type of support and anchor. Submit pipe hanger and support schedule showing Manufacturer's figure number, size, location, and features for each required pipe hanger and support.

INSTALLATION

Examine the Contract Drawings and specifications in order to insure the completeness of the work required under this Section. Provide supplementary parts necessary to complete work, though not specifically indicated on Drawings or specified herein.

Verify measurements and dimensions at the job site and cooperate in the coordination and scheduling of the work of this Section with the work of related trades, so as not to delay job progress.

Proceed with installation of hangers, supports and anchors only after required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) proper placement of inserts, anchors and other building structural attachments.

Prior to installation of hangers, supports, anchors and associated work, Contractor shall meet at project site with installer of each component of associated work, inspection and testing agency representatives (if any), installers of other work requiring coordination with work of this section and Engineer for purpose of reviewing material selections and procedures to be followed in performing the work in compliance with requirements specified.

Install hangers, supports, clamps and attachments to support piping and ducts properly from building structure. Arrange for grouping of parallel runs of horizontal piping to support together

on trapeze type hangers where possible. Install supports as directed by the Engineer. Do not use wire or perforated metal to support piping and ducts.

Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories.

Hanger Adjustment: Adjust hangers so as to distribute loads equally on attachments.

Support Adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.

Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touchup paint.

SUPPORT SPACING

Steel pipes:

Diameter	Maximum spacing	Size of threaded rod
1/2", 3/4", 1”	150cm	10mm
11/4”, 11/2”, 2”	250cm	10mm
21/2”, 3”	350cm	12mm
4”, 5”	420cm	16mm
6”	520cm	22mm
8”, 10”, 12”	600cm	25mm

PVC pipes:

Diameter	Maximum spacing	Size of threaded rod
2”	90cm	10mm
3”, 4”	120cm	12mm
5”, 6”	180cm	16mm
8”, 10”	215cm	16mm

Ducts:

Duct size	Maximum spacing	Size of threaded rod
Up to 700mm	240cm	6mm
720 to 1050mm	180cm	8mm
Above 1050mm	100cm	10mm

SECTION 07- PAINTING

GENERAL

Provide labor, materials, equipment and services, and perform operations required for complete installation of painting and related works as specified herein.

QUALITY ASSURANCE

Materials shall conform to the latest edition of industry standards and reference specifications specified herein and to applicable codes and requirements of local authorities having jurisdiction, whichever is more stringent.

MATERIALS

The primer and finishing coats for painting hot surfaces shall be special heat resistant type acrylic base paint.

The primer and finishing coats for painting cold surfaces shall be acrylic base paint.

APPLICATION

Surfaces requiring prime painting shall be cleaned thoroughly of rust, scale, oil, grease and dirt. Use wire brushing, sand blasting or solution cleaning as needed.

All items that have rusted or corroded shall be cleaned and/or painted to the satisfaction of the engineer. No painting shall be applied on rusted, damp or dirty surfaces.

Provide etching agent for galvanized surfaces prior to primer and finishing coat.

The paint shall be evenly and well brushed out to prevent drops, runs or saggings. Care shall be taken not paint over controls, labels and nameplates.

All black steel piping including flanges, bolts, nuts, cast iron valves and accessories, valve wheels and all ferrous parts are to be painted with two coats of zinc chromate primer, wherever or not they are to be insulated. When bare or exposed to view, they are to be further painted with two coats of approved oil paint.

Hangers and supports including clamps, rods, bolts, nuts etc… to be painted with two coats of zinc chromate primer and where exposed to view with two additional coats of approved oil paint.

Equipment and panels shall have two shop priming coats of corrosion protective paint and at least two factory applied finishing coats.

All factory painted surfaces shall be cleaned thoroughly and inspected on site for scratches and etching and shall be retouched where necessary.

The finishing coat colors shall follow ASME color code.

The type and flow direction of the fluid conveyed in pipes and ducts shall be painted in red at intervals not exceeding four meters and at all crossings through slabs and walls.

SECTION 08 - PIPE AND DUCT INSULATION

GENERAL

Provide labor, materials, equipment and services, and perform operations required for complete installation of Insulation and related work as indicated on the drawings and specified herein.

Work included: the work shall include, but not be limited to pipe insulation and A/C duct insulation

QUALITY ASSURANCE

Materials shall conform to the latest edition of industry standards and reference specifications specified herein and to applicable codes and requirements of local authorities having jurisdiction, whichever is more stringent.

SUBMITTALS

Product Data: Submit names of manufacturer and copies of latest published literature including types, applications and thermal characteristics for materials specified herein for approval; obtain written approval before ordering materials.

Samples: Submit samples of materials specified herein for approval; obtain approval before ordering materials.

DELIVERY, STORAGE AND HANDLING

Deliver materials and handle to prevent the inclusion of foreign materials and the damage of materials by water or breakage.

Store materials and equipment where designated and within the manufacturer's recommended temperature range. Assume responsibility and security for materials and equipment and take precautions for protection from detrimental conditions.

MATERIALS

Pipe Insulation

- All domestic hot water pipes shall be insulated with Tubo-Foam, 20mm thick:
- Chilled water pipes till 1”, under false ceiling: 64 Kg/m³, 25mm thickness.
- Chilled water pipes 11/4” and above: 64 Kg/m³, 40mm thickness.
- Chilled water pipes at roof level: 64 Kg/m³, 50mm thickness.
- A/C drainage exposed pipes: Tubo-Foam, 13mm thickness.

A/C refrigerant pipes shall be insulated with synthetic rubber material 1/2" thickness.
All A/C ducts shall be insulated with blanket type fiber glass having a maximum thermal coefficient of K=0.3 Btu/Hr/°F/Ft².
Insulation to be rigidly fixed on ducts by an approved method and recovered by asphalt paper with aluminum foil.
The minimum insulation thickness for ducts to be 25 mm.
The minimum insulation density to be 24 Kg/m³.

Jacketing
Outdoor pipes and ducts shall be protected with an aluminum metal jacketing.

Jacketing to be 6/10 mm thickness with riveted joints with approved waterproof seal on all joints.

Embedded pipes
All embedded pipes shall be wrapped with asphaltic corrosion protection materials, as “PREMCOTE”. (Straight run to be wrapped before testing and elbows, tees and accessories after testing).

INSTALLATION

Install all pipe and duct insulation in accordance with the following requirements :
No insulation shall be applied until pipes or ducts have been tested and found correct.
All insulation shall be applied by skilled laborers of a specialized sub-contractor.
Insulation to be applied so as to give smooth homogeneous and fine surface.
Insulation shall fit tight to the surfaces to be covered and any surface irregularities left shall be repaired.
All insulation joints, tees and elbows shall be covered with canvas and foster material, as well as for all pipes inside technical rooms and technical channels.
Foster material to be 30-36 for indoor application and 30-80 for outdoor application.
All insulation materials shall be properly stored in a suitable manner so as to protect them from damage or deterioration before installation.

SECTION 09 - WATER DISTRIBUTION SYSTEM

GENERAL

Provide labor, materials, equipment and services, and perform operations required for complete installation of the Water Distribution System and related work as indicated on the drawings and specified herein.

Work Included: The work shall include, but not be limited to, the following:
1. Air vents.
2. Water hammer arrestor.
3. Water tanks.

QUALITY ASSURANCE

Materials and work shall conform to the latest edition of industry standards, reference specifications listed below and specified herein and to applicable codes and requirements of local authorities having jurisdiction, whichever is more stringent.

SUBMITTALS

Product Data
1. Submit copies of manufacturer's latest published literature for materials specified herein for approval. Obtain approval before ordering materials.
2. Data shall include manufacturer's technical product data, including installation instructions, and dimensioned drawings for each type of manufactured piping specialty. Include pressure drop curve or chart for each type and size of pipeline specialty. Submit schedule showing manufacturer's figure number, size, location, and features for each required piping specialty.

DELIVERY, STORAGE AND HANDLING

Deliver materials and handle so as to prevent the inclusion of foreign materials and the damage of materials.

Store materials and equipment where designated. Contractor shall assume responsibility and security for materials and equipment. Take precautions for protection from detrimental conditions.

MATERIALS

Automatic Air Vents
Automatic air vents shall be installed as shown on the drawings and where indicated by the Engineer.
Automatic air vents of the ball float type shall be installed at all high points in the piping systems. They shall support a working pressure up to 16 Kg/cm².
Mechanism of automatic air vent shall be interchangeable.

Water Hammer Arrestors

Water hammer arrestors (shock absorbers) shall be installed as shown on the drawings. They shall have a stainless steel shell, cast iron body, with inside bellows constructed of an elastomer material, a pneumatic displacement gas cushion and a hydraulic displacement fluid.

Water Tanks
Roof cold water tank shall be made of polyethylene factory assembled, with sunlight resistant material.
Each tank shall be provided with manhole, overflow connections, drain pipe, vent outlet, fixing supports and all necessary accessories.
The group shall be provided with supply float valves and outlets with gate valves for connection to the distribution system.

INSTALLATION

Examine conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

Examine the Contract Drawings and specifications in order to insure the completeness of the work required under this Section.

Verify measurements and dimensions at the job site and cooperate in the coordination and scheduling of the work of this Section with the work of related trades, so as not to delay job progress.

Connections to fixtures, equipment and concrete water tanks shall conform to local applicable code requirements.

Provide automatic air vent valves at high points in water systems; pipe drain lines to nearest indirect waste. In general, pitch piping up in direction of water flow.

After installation of piping and before connection of any fixtures, equipment or reducing valves, test the system under hydrostatic pressure.

Balance the hot water system for satisfactory circulation to assure water within the required temperature limits.

After installation of water treatment system equipment, test the water quality in different stage, and report results in writing.

SECTION 10 - DRAINAGE AND VENT SYSTEMS

GENERAL

Provide labor, materials, equipment and services, and perform operations required for complete installation of the Drainage and Vent Systems and related work as indicated on the drawings and specified herein.

Work Included: The work shall include, but not be limited to, the following:
1. Roof Drains.
2. Balcony drains.
3. Floor drain with trap for toilets.
4. Channel.
5. Cleanouts.
6. Vent caps.
7. Parking drains.

QUALITY ASSURANCE

Materials and work shall conform to the latest edition of industry standards, reference specifications listed below and specified herein and to applicable codes and requirements of local authorities having jurisdiction, whichever is more stringent.

SUBMITTALS

Product Data
1. Submit copies of manufacturer's latest published literature for materials specified herein for approval. Obtain approval before ordering materials. Data shall include the following:
2. Manufacturer's technical product data, including installation instructions, and dimensioned drawings for each type of manufactured piping specialty. Submit schedule showing manufacturer's figure number, size, location and features for each required piping specialty.

DELIVERY, STORAGE AND HANDLING

Deliver materials and handle so as to prevent the inclusion of foreign materials and the damage of materials.

Store materials and equipment where designated. Contractor shall assume responsibility and security for materials and equipment. Protect from detrimental conditions.

MATERIALS

Roof Drains
Roof drain shall be PVC body with dome.

Balcony Drains
Rain water drainage through floor of balconies shall be ensured by means of floor drains with horizontal discharge.
Each drain shall be of PVC body with stainless steel grating.

Floor Drains with Trap for Toilets

These floor drains shall be for installations executed under the floor tiles. They shall be of PVC with multiple waste inlet connections.
Cover plate and frame shall be of chrome plated brass.

Channel with Reinforced Grid Cover in Parking Entrance
The channel is made of concrete. Its grid cover shall be made of painted steel.

Cleanouts
The cleanouts shall be of the same material and dimensions as the pipes to be cleaned and shall be placed under the floor slabs or extended through to terminate flush with the finished floor.
Floor cleanouts with covers shall be formed with a "Y", "F" or 45 elbow fitting of the same material and size as the pipe accommodated and provided with an adapter and a threaded brass plug.
Cover plate and frame shall be 20 x 20cm chrome plated brass. The cover shall be threaded to the frame to ensure an air tight closure.

Vent Caps
Vent caps shall consist of galvanized wire basket screens with round inlet to fit snugly inside the open end of the vent pipe.

Parking Drains
Parking drains shall be PVC body, down discharge, with PVC cover heavy duty (10KN).

INSTALLATION

Examine conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

Examine the Contract Drawings and specifications in order to insure the completeness of the work required under this Section.

Verify measurements and dimensions at the job site and cooperate in the coordination and scheduling of the work of this Section with the work of related trades, so as not to delay job progress.

Pitch horizontal piping not less than 1/8 inch per foot down in direction of flow.

Individually trap fixtures.

Do not trap vent piping; grade to drip back to a waste or soil line.

Make changes in direction of piping with long radius fittings.

Set floor drains below the normal finished floor, with a gradual pitch extending away from the drain.

Keep pipe and fittings clean; plug exposed ends of incomplete or unconnected work.

Place cleanouts at changes in direction:

1. Cleanouts on concealed piping shall be extended through and terminate flush with the finished floor.

2. They shall be also provided at or near the foot of each vertical soil and waste stack.
3. Cleanouts shall be installed such that the cleanout opens in a direction opposite to the flow of the drainage line or at right angles thereto.

Make connections between dissimilar pipes with approved dielectric adapters.

Flash floor drains above ground floor and roof drains with 6 psi lead sheet, unless otherwise approved.
Clamp floor drains penetrating waterproofing membrane to the membrane.

Supply clamping collars with drains where flashing is required or waterproofing membrane is penetrated.

Make pipes and drains penetrating the ground floor watertight with an approved glass wool, rope or mastic sealing compound or modular, mechanical link assembly. Cap as required to assure fireproof integrity.

FIELD QUALITY CONTROL

Perform tests in the presence of the authorities having jurisdiction and the Employer's representative.

When the roughing-in work is completed and before connection of fixtures, subject drainage (drains and vents) systems to the following tests as a minimum requirement in addition to tests required by local authorities.

Water Test

a. Apply the water tests to every part of each drainage system. Test each system in its entirety or in sections. Tightly close openings in the piping.
c. If testing the system in sections, tightly plug each opening, except the highest opening of the section being tested, and fill each section with water. Test every section with a head of water equivalent to the greatest floor-to-floor distance between floors with a minimum of at least a 10 foot head of water.
d. Keep the water in the system, or in the portion under test, for at least 15 minutes before inspection starts.
e. There shall be no leakage.

Correct defects detected by any test and retest.

PROTECTION

The Contractor shall be responsible for repairing and replacing plumbing materials and equipment, whether or not installed, which are damaged due to freezeups, until the systems are approved by the Engineer and turned over to the Employer.

SECTION 11 - PUMPING SYSTEMS

GENERAL

Provide labor, materials, equipment and services, and perform operations required for complete installation of Pumping System and related work as indicated on the drawings and specified herein.

Work Included: The work shall include, but not be limited to, the following:
1. Pressure Pumping Systems for cold water.
2. Fire fighting pumps.
3. Lifting pumps for sewage sump pit.

QUALITY ASSURANCE

Materials and work shall conform to the latest edition of reference specifications, industry standards listed below and specified herein and to applicable codes and requirements of local authorities having jurisdiction, whichever is more stringent.

Tests: Test pumping system in accordance with the appropriate section of the specification describing each system.

SUBMITTALS

Product Data: Submit copies of manufacturer's latest published literature for materials and equipment specified herein for approval; obtain approval before ordering materials.

Shop Drawing :
In addition to the stipulations for shop drawings given under General Requirements, the following shop drawings for each pump shall be submitted for approval prior to shipment from the factory.
1. Certified performance curves showing job number, customer order number, pump designation number shown on drawings, date of manufacture, model number, serial number, pump size, impeller diameter, impeller type, maximum impeller diameter pump can accommodate, rpm, flow head characteristics curve, consumed horsepower curve and pump efficiency curve.
2. Pump cross-sectional drawing showing major components with parts numbers and parts list.
3. Pump outline dimensional drawing showing overall dimensions, location of foundation bolt holes and size, location and rating of suction and discharge nozzles.
4. Recommended list of spare parts.
5. Installation, operation and maintenance instruction manual.
6. Details and wiring diagrams of factory or field supply electrical devices, controls or accessories.
7. Motor data such as make, model number, serial number, horsepower rating, rpm, voltage, phase, frequency, class of insulation, allowable temperature rise, full load amperes and locked rotor amperes.
8. Starter data such as make, model number, size, ampere rating, line voltage, control voltage and frequency.

DELIVERY, STORAGE AND HANDLING

Exercise proper care in the handling of work so as not to injure the finished surfaces, and take proper precautions to protect the work from damage after it is in place.

EQUIPMENT

PRESSURE PUMPING SYSTEMS (cold water)

1. General
   The Contractor shall supply and install the domestic cold water pressure pumping systems: The automatic pressure maintaining pumps for each system shall be supplied as a packaged unit, preassembled and factory tested with its wired up control panel.
   The supply shall comprise:
   a. Two pumps and motors operated by pressure switches wired to the motor starters.
   b. One pressure vessel, precharged with air or nitrogen and containing an impermeable synthetic rubber diaphragm separating air and water.
   c. Necessary pressure switches high and low, control and pressure gauges.
2. Pumps
   The water pumps shall be of the base-mounted, vertical multi-stage centrifugal type, with back to back impeller to balance axial thrust for high head requirement, directly connected to the electric motor through a heavy duty flexible coupling.
   The material for the pump casing shall be close grain cast iron, Gunmetal Phosphor bronze impeller, stainless steel shaft, intermediate bronze bearing and ceramic tungsten carbide bottom bearing and shaft seal.
   The suction and delivery flanges shall have renewable casing sealing rings. The impeller shall be of an enclosed type, accurately machined and keyed to the shaft and interchangeable. The shaft shall be machined and ground to fine tolerances. The pump shall be provided with flanges for the suction and discharge connections.
   The motor shall be of the totally enclosed, fan cooled, drip-proof, squirrel-cage, induction type with permanently lubricated and sealed ball bearings, and class F insulation.
   The performance specified in the drawings shall be achieved under continuous operation.
   The base plate shall be provided with bolt holes for anchor bolts and shall be protected with anticorrosion paint.
   The electric motor direction of rotation shall be clockwise when viewed from the drive end at 1450 rpm, the pump shall be fitted with self-adjusting mechanical seal with carbon rotating face running against a stationary ceramic seat.
   All wiring from control panel to motor and to pressure switch shall be run in flexible metal conduit.
3. Pump Accessories
   Each pump shall be supplied complete with all necessary accessories and mainly :
   - Suction and discharge gate valves.
   - Check valve at discharge side.
   - Strainer at suction side.
   - Flexible joints at both suction and discharge.
   - Vibration isolation pads.
   - Pressure gauges.
4. Control Panel for Pumping System
   The electric control panel (Electronic) of each pumping system shall be fabricated from heavy gauge mild steel sheet and finished with stoved hammer paint both internally and externally.
   The control panel shall be complete with :
   Direct-on-line starting up to 10 kW (or Star Delta for higher ratings)
   Run indicator lights.
   Fault indicator lights.
   Control fuses.

   Power fuses (or circuit breakers instead of fuses).
   Mains isolator interlocked with door.

An automatic device alternate the pumps at each start to maintain equal use and to run the next pump after a default.
The possibility of simultaneously running of all pumps (cascade).
Hand-off auto switch.
Float switches if required.
The pump set shall also be provided with adjustable overload relays, all fully wired to motors and pressure switches (if existing) requiring only connecting to mains supply.
Installation and protection of control panel shall be IP55.

FIRE FIGHTING PUMPS

1. General
   The Contractor shall supply and install the fire fighting pumping set:
   The automatic pressure maintaining pumps for each system shall be supplied as a packaged unit, preassembled and factory tested with its wired up control panel.
   The supply shall comprise:
   a. Two pumps UL listed according to NFPA 20, and motors operated by pressure switches wired to the motor starters.
   b. Pressure relief valve and pressure test pipe till water tank.
   c. Necessary pressure switches, control and pressure gauges.
   d. Pressure sensor on discharge header for connection to fire alarm panel.
2. Pumps
   The main fire pumps shall be of the base-mounted, end suction, single stage type, directly connected to the electric motor through a heavy duty flexible coupling.
   The material for the pump casing shall be close grain cast iron, Gunmetal Phosphor bronze impeller, stainless steel shaft, intermediate bronze bearing and ceramic tungsten carbide bottom bearing and shaft seal.
   The suction and delivery flanges shall have renewable casing sealing rings. The impeller shall be of an enclosed type, accurately machined and keyed to the shaft and interchangeable. The shaft shall be machined and ground to fine tolerances. The pump shall be provided with flanges for the suction and discharge connections.
   The motor shall be of the totally enclosed, fan cooled, drip-proof, squirrel-cage, induction type with permanently lubricated and sealed ball bearings, and class F insulation.
   The performance specified in the drawings shall be achieved under continuous operation.
   The base plate shall be provided with bolt holes for anchor bolts and shall be protected with anticorrosion paint.
   The electric motor direction of rotation shall be clockwise when viewed from the drive end at 2900 rpm, the pump shall be fitted with self-adjusting mechanical seal with carbon rotating face running against a stationary ceramic seat.
   All wiring from control panel to motor and to pressure switch shall be run in flexible metal conduit.
3. Pump Accessories
   Each pump shall be installed with all necessary accessories and mainly :
   - Suction and discharge gate valves.
   - Check valve at discharge side.
   - Flexible joints at both suction and discharge.
   - Vibration isolation pads.
   - Pressure gauges.
4. Control Panel for fire pumps
   The electric control panel (Electronic) of each pumping system shall be fabricated from heavy gauge mild steel sheet and finished with stoved hammer paint both internally and externally.

   The control panel shall be complete with :
   Direct-on-line starting up to 10 kW (or Star Delta for higher ratings)
   Run indicator lights.

Fault indicator lights.
Control fuses.
Power fuses (or circuit breakers instead of fuses).
Mains isolator interlocked with door.
An automatic device alternate the two pumps at each start to maintain equal use and to run the next pump after a default.
Hand-off auto switch.
Float switches if required.
Interconnection to fire alarm panel.
The pump set shall also be provided with adjustable overload relays, all fully wired to motors and pressure switches (if existing) requiring only connecting to mains supply.
Insulation and protection of control panel shall be IP55.

SEWAGE WATER LIFTING PUMPS

1. General
   The Contractor shall supply and install the sewage water lifting pumping system, which shall comprise:
   a. Two pumps and motors operated by float switches wired to the motor starters.
   b. Three steps (lead-lag, duplicate, alarm) float arm.
   c. Necessary controls.
2. Pumps
   The pumps shall be submersible type, with single vane cast iron impeller, suitable for at least 50mm solid material, cast iron body, stainless steel shaft directly connected to the electric motor with mechanical seal.
   The motor shall be squirrel cage, induction, with maximum spaced 15 starts per hour. Motor shall be class F insulation, 1450 rpm.
   Control wires and cables shall be suitable for under water installation.
3. Pump Accessories
   Each pump shall be supplied complete with all necessary accessories and mainly :
   - Discharge gate valve.
   - Discharge check valve.
   - Discharge flexible.
   - Guide bar for dismantling.
4. Control Panel for sewage pumps
   The electric control panel of each pumping system shall be fabricated from heavy gauge mild steel sheet and finished with stoved hammer paint both internally and externally.
   The control panel shall be complete with :
   Direct-on-line starting up to 10 kW (or Star Delta for higher ratings)
   Run indicator lights.
   Fault indicator lights.
   Control fuses.
   Power fuses (or circuit breakers instead of fuses).
   Mains isolator interlocked with door.
   An automatic device alternate the two pumps at each start to maintain equal use with possibility for duplicate running controlled by 2nd step of float switch.
   Alarm buzzer controlled by 3rd step of float switch.
   The run of the next pump after a default.
   Hand-off auto switch.
   Float switches if required.
   The pump set shall also be provided with adjustable overload relays, all fully wired to motors.

INSTALLATION

Contractor shall be responsible for accurately checking all pumping heads, based upon the actual piping and equipment installation, and be responsible for furnishing pumps and motors of proper sizes for the actual service, regardless of those scheduled on plan.
Pumps shall be provided from the factory complete with their electric motors. Motors shall be either close- coupled to the pump or flexibly coupled to it as specified for the particular pump concerned.
Horizontal base mounted pumps shall have their motor mounted on a common cast iron or fabricated steel base and properly aligned at the factory.
The pump (domestic and fire) and motor base shall be supported on an isolated reinforced concrete foundation and the base shall be aligned and leveled throughout its entire length and width.
Where necessary, suitable shims shall be provided under the base to facilitate leveling.
The pump and motor base shall be secured to the foundation with proper size anchor bolts and completely grouted in to provide a rigid non-deflecting support.
The alignment of the pump and motor shall be checked and adjusted if necessary after grouting-in the base and connecting piping.
Sump pump shall be supported to the base of lifting pipe which shall be secured to pit slab.
Piping shall be supported independently to prevent piping weight or stresses from bearing on or being transmitted to the pump.
Pumps shall be located in accessible locations for ease of repair and maintenance.
Drain from pump bases shall be piped to the nearest floor drain or sump.
Pumps shall be constructed of specified materials and shall have pressure ratings suitable for the service and operating conditions.
Where there is a possibility of problems with corrosion, the appropriate corrosion resistant materials and assembly methods shall be used including isolation of dissimilar metals against any electrolytic corrosion.
Pump impellers and rotating assemblies shall be statically and dynamically balanced at the factory.
Pumps shall be provided from the factory with plugged connections for casing vent, drain, suction and discharge pressure gauges. Heavy gauge coupling guards shall be provided. Low-level sensors will be installed to provide power cut-off and prevent the running of the pumps.
Before operating, care shall be taken to ensure that pumps are properly lubricated, rotating elements, rotate freely, the casings are vented and full of water, the direction of rotation is correct, the strainers are clean and the suction and discharge valves are open.
Pumps shall operate stably without pulsation, vibration, noise or cavitation throughout their full capacity range.
Pumps shall be selected such as that operating levels of flow and head fall near the point of maximum efficiency as obtained from the manufacturer's published data. Pumps shall never be selected to operate near the end of their curve.
A pump shall not be selected with the largest size impeller that it can accommodate.
The horsepower rating of pump motors shall be of such magnitude as to ensure non-overloading of the motor throughout the capacity range of the pump for the impeller diameter selected.
Electric motors shall always be specifically supplied for the available electric current characteristics of voltage and frequency. Motor speed shall not exceed 1450 rpm unless specified otherwise.

SECTION 12 – DOMESTIC WATER HEATERS

GENERAL

Provide labor, materials, equipment and services, and perform operations required for complete installation of Domestic Water Heaters and related work as indicated on the drawings and specified herein.

Work included: The work shall include, but not be limited to, the following:
1. Electric water heater.

QUALITY ASSURANCE

Materials and work shall conform to the latest edition of reference specifications, industry standards listed below and specified herein and to applicable codes and requirements of local authorities having jurisdiction, whichever is more stringent.

Tests: Test electric water heaters in accordance with the appropriate section of the specification describing each system.

SUBMITTALS

Product Data: Submit copies of manufacturer's latest published literature for materials and equipment specified herein for approval; obtain approval before ordering materials.

DELIVERY, STORAGE AND HANDLING

Exercise proper care in the handling of work so as not to injure the finished surfaces, and take proper precautions to protect the work from damage after it is in place.

MATERIAL

The water heater shall be of the cylindrical, storage type, comprised of inner tank, outer jacket, immersion type electrical heating elements, thermostat and electric control box for electric heater and steel heat exchanger for hot water storage tank as well as pressure and temperature relief valve, water connections and sturdy floor mounting legs or wall brackets suitable for the type of heater used.
The inner tank shall be constructed of heavy gauge submerged arc-electric welded steel, designed for a working pressure of 10 bars and hydrostatically tested to 150 psig at the factory. The tank shall be glass lined with vitreous porcelain enamel tank liner. The tank shall be provided with stainless steel cold water dip tube to carry the incoming cold water to tank bottom to prevent mixing with heated water, and with anti-siphoning opening at top to prevent siphoning out of contents in the event of water supply shut-off. The tank shall be provided with 1/2" drain connection with 1/2" drain valve at bottom, 1/2" relief valve connection at top and water inlet and outlet connections.

The outer jacket shall be of heavy gauge steel, rust proofed with two coats of anti-rust paint inside and outside and smoothly finished with durable baked-on high gloss enamel. The space between the tank and the outer jacket shall be filled with blanket type glass fiber insulation of adequate thickness for minimum heat loss.
The heater shall be provided with a magnesium anode rod to protect the heater against electrolytic corrosion.

A 1/2" combination temperature and pressure relief valve shall be fitted to the heater. The relief valve shall be of the self-closing, lever-operated type, with thermo-bulb extension, factory set at maximum working pressure and 210 deg. F.

The electric heater shall be provided with immersion type electric heating elements, with 4-bolt, 2 1/2" bolt hole circle size, fitted into the tank with steel forged adapters. The heating elements shall be removable without draining the tank. Each heating element shall be equipped with separate contractor and high limit temperature control to cut-off the energy supply in the event of overheating. The heating elements shall be controlled by one thermostat to cut off all heating elements simultaneously.

The thermostat shall be of the adjustable type with a range of temperature adjustment not less than 90 to 190 deg.F. It shall be of the immersion type with bulb immersed directly into the water.

The water heater shall be provided with an electric control box mounted on the heater at the factory and shall contain the contactors, thermostat, necessary transformer and junction box. It shall be fully wired and tested at the factory ready for installation with simple connection to the power supply.

SECTION 13 – SANITARY FIXTURES

GENERAL

Provide labor, materials, equipment and services, and perform operations required for complete installation of sanitary fixtures and related work as indicated on the drawings and specified herein.

Work Included: The work shall include, but not be limited to, the following:
1. WC's cistern and seat (wall hanged or floor mounted).
2. Lavatories.
3. Showers.
4. Kitchen sink and mixers.

QUALITY ASSURANCE

Materials and work shall conform to the latest edition of industry standards, reference specifications specified herein and to applicable codes and requirements of local authorities having jurisdiction, whichever is more stringent.

SUBMITTALS

Product Data: Submit copies of manufacturer's latest published literature for materials specified herein for approval, and obtain approval before ordering materials.

Shop Drawings: Submit shop drawings for work specified herein for approval.

Maintenance Data: Submit maintenance data and spare parts lists for each type of manufactured piping specialty. Include this data, product data, and shop drawings in maintenance manual.

DELIVERY, STORAGE AND HANDLING

Deliver materials and handle so as to prevent the inclusion of foreign materials and the damage of materials.

Store materials and equipment where designated. Assume responsibility and security for materials and equipment and protect from detrimental conditions.

MATERIALS

SANITARY FIXTURES
REFER TO LIST OF MANUFACTURER SECTION FOR MODEL SELECTION OF FIXTURES, TAPS AND MIXERS

European Water Closet
- Vitrous China with WC inlet and outlet connections.
- Plastic seat and cover from the same manufacturer.
- Concealed cistern for wall hanged WC's and exposed cistern for floor mounted WC.
- Paper holder.
- Flush valve, concealed type for public WC's.

Wash Hand Basin
Vitrous China wash basin, built in, vanity or pedestrial type.

Chromium plated angle valve, with clamp ring, union and extension piece.
11/2" diameter chromium plated trap, of the bottle type with extension tube and wall flange.
Chromium plated waste drain.
Chrome plated handles and mixer.
Towel holder, mirror, shelf, soap dispenser and paper holder.
Public toilets lavatories to be sprayable material finish.

Kitchen sinks

- Acrylic solid surface or sprayable material.
- Kitchen sink with single or double bowl.
- Single hole sink mixer.
- Drinking water tap.
- Chrome plated handles.
- ½" diameter angle valves.
- One polypropylene bottle trap 2" diameter with strainer, overflow and waste plug.
- Soap holder.

Showers

White enameled shower tray including outlet trap, and shower mixer, shower head, hand shower and chrome plated handle.

INSTALLATION

Examine conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

Examine the Contract Drawings and specifications in order to insure the completeness of the work required under this Section.

Verify measurements and dimensions at the job site and cooperate in the coordination and scheduling of the work of this Section with the work of related trades, so as not to delay job progress.

The installation and connection of all sanitary fixtures shown on the drawings or provided later shall satisfy the following specifications:

- Ample application of petroleum jelly shall be applied to all surfaces of exposed chrome plated piping, valves and fittings and stainless steel fixtures immediately after installation.
  Concealed brackets, hangers and plates shall have a shop coat of paint.
- All exposed piping and trim shall be chrome plated and fully protected during installation.
  Strap or padded wrenches shall be used on chrome pipe fittings and valves.
  All exposed metal parts in the sanitary blocks shall be chrome plated.
  All exposed valves in the sanitary blocks shall be chrome plated of the recessed type.
- Plumbing fixtures shall be complete with all required trimmings, including faucets, waste plugs, traps, supplies, stop valves, escutcheons and casings and all necessary hangers, plates, brackets, anchors and supports.
- All fixtures shall be individually trapped.
- All fixtures shall be equipped with chrome plated angle valves, whether specified, shown on drawings or not.

- Fixtures shall be set in a neat, finished and uniform manner making the connection to all fixtures at right angles with the walls, unless otherwise directed by the Engineer.
  Roughing for this work must be accurately laid out so as to conform with the finished wall material.
  Fixtures are not to be set until so directed by the Engineer.

- The location and disposition of all items shall be as indicated on the relevant drawings.
  It is to be noted that all fixtures mentioned below shall be approved for shapes and colors before ordering.

SECTION 14 - FIRE FIGHTING EQUIPMENTS

GENERAL

Provide labor, materials, equipment and services, and perform operations required for complete installation of fire fighting system and related work as indicated on the drawings and specified herein.

Work Included: The work shall include, but not be limited to, the following:
1. Portable and automatic fire extinguishers.
2. Fire hose cabinets.
3. Two way Siamese connections.
4. Test and drain valves.
5. Landing valves.

QUALITY ASSURANCE

Materials and work shall conform to the latest edition of industry standards, reference specifications specified herein and to applicable codes and requirements of local authorities having jurisdiction, whichever is more stringent.

SUBMITTALS

Product Data: Submit copies of manufacturer's latest published literature for materials specified herein for approval, and obtain approval before ordering materials.

Shop Drawings: Submit shop drawings for work specified herein for approval.

Maintenance Data: Submit maintenance data and spare parts lists for each type of manufactured piping specialty. Include this data, product data, and shop drawings in maintenance manual.

DELIVERY, STORAGE AND HANDLING

Deliver materials and handle so as to prevent the inclusion of foreign materials and the damage of materials.

Store materials and equipment where designated. Assume responsibility and security for materials and equipment and protect from detrimental conditions.

MATERIALS

PORTABLE FIRE EXTINGUISHER

Supply and install all portable fire extinguishers wherever shown on the drawings and as specified herein:

1. Dry chemical “ABC” type of 6 KG or 9 KG capacity (90% concentration).
2. Heavy duty drawn steel cylinder with hard, scratch-resistant red enamel finish.
3. All brass operating valve, large size operating lever, full vision pressure gauge and discharge hose.

AUTOMATIC ABC FIRE EXTINGUISHER

Supply and install automatic dry chemical ABC fire extinguishers as shown on the drawings and as specified for portable fire extinguishers with additional fusible link head with spray distribution nozzle.

PORTABLE CO2 FIRE EXTINGUISHER

Supply and install all CO2 fire extinguishers in the electrical rooms, and in the lifts machinery rooms as specified herein:

1. CO2 type of 6 KG capacity.
2. Heavy duty drawn steel cylinder with hard, scratch-resistant red enamel finish.
3. All brass operating valve, large size operating level, full vision pressure gauge and discharge hose.
4. Breath protection cover.

Installation of extinguishers shall be according to NFPA 10 inside wall cabinet.

FIRE HOSE REEL

Supply and install all fire hose reel cabinets wherever shown on the drawing and as specified herein:

- Hose size: 25mm (1”).
- Hose length: 20 meters.
- Nozzle type: adjustable.
- Fire extinguisher: 6 Kg, ABC.
- Cabinet: steel with red enameled finish.
- Accessories: gate valve, swing hose with 1/4 turn monitor.

Fire extinguisher can be installed adjacent or below hose reel according to space requirements.

TWO WAY SIAMESE CONNECTIONS

Supply and install two way Siamese connections, connected to fire hose reel system as specified herein:

- Free standing hydrant.
- Cast brass straight body chromium plated finish for exposed parts.
- Inlets: 2 x 21/2” threaded with brass chain.
- Main pipe: 6”.
- Hydrant to be approved by fire department.

TEST AND DRAIN VALVES

Supply and install test and drain valve wherever shown on the drawings and as specified herein:

Combined test and drain valves with spring loaded position indicator with positive shut-off complete with tempered glass self cleaning sight glass. Bronze body and ball, brass stem, steel handle and Teflon seat.

LANDING VALVES

Supply and install landing valve wherever shown on the drawings and as specified herein:
Landing valve is to be horizontal or oblique type, made of gunmetal construction, flanged inlet with instantaneous quick coupling and cap outlet compatible with local fire authority requirements.

INSTALLATION

Install fire extinguishers and landing valves in location and at mounting heights indicated, or if not indicated, at heights to comply with applicable regulations.
Furnish requirements to building trade for recesses needed in walls, as required by type and size of cabinet and to comply with manufacturer's instructions.

SECTION 15 - COOLING PLANT

GENERAL

Provide labor, materials, equipment and services, and perform operations required for complete installation of the cooling plant units and related work as indicated on the drawings and specified herein.

Work Included: The work shall include, but not be limited to, the following:
1. Air-cooled chillers
2. Pumps
3. Closed expansion tanks
4. Plate heat exchanger
5. Motor control center
6. Provide factory-mounted and wired controls and electrical devices as specified.

QUALITY ASSURANCE

Materials shall conform to the latest edition of industry standards and reference specifications specified herein and to applicable codes and requirements of local authorities having jurisdiction, whichever is more stringent.

Tests: Test cooling plant system in accordance with the appropriate section of the specifications describing each system.

SUBMITTALS

Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights, furnished specialties and accessories and installation and startup instructions.

Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances and methods of assembly of components.

Wiring Diagrams: Submit manufacturer's electrical requirements for power supply wiring to all cooling plant equipments. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation of equipments and controls. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

Maintenance Data: Submit maintenance data and parts list for each equipment control and accessory, including "troubleshooting" maintenance guide. Include this data and product data in maintenance manual booklet.

DELIVERY, STORAGE AND HANDLING

Handle equipments and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged units or components; replace with new.

Store equipments and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.

Comply with manufacturer's rigging and installation instructions for unloading equipments, and moving units to final locations for installation.

WARRANTY

Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, motors/compressors with inadequate and defective materials and workmanship, including leakage, breakage, improper assembly or failure to perform as required. Manufacturer's instructions for handling, installing, protecting and maintaining units must be adhered to during warranty period. Replacement includes component replacement and labor for removal, reinstallation and retesting and balancing.

Warranty Period: Two years from Date of Substantial Completion.

Contractor shall include separate service Contract for Labor, if required.

MATERIALS

AIR COOLED CHILLER

General
Furnish and install factory-assembled one piece air- cooled chillers. Units shall be completely charged at the factory with refrigerant 134a. All factory wiring and piping shall be contained within the unit enclosure, all electrical components shall be protected from the weather. The unit shall be enclosed in a galvanized steel casing, with baked enamel finish.
Each unit shall be certified by Underwriter's Laboratories Machine and shall be complete with screw type compressor, air-cooled condenser, copper tube and aluminum fins.
Capacity of each unit shall be as indicated on the drawings.
Contractor to submit optional price for unit with refrigerant 407 C.

Description
1. General
   Unit electrical power shall be 230 volts, 3 phases, 50 Hz.
   Control power shall be 220 or 24 volts, single phase, 50 Hz.
   Construction and ratings shall be in accordance with latest ARI Standard 590 and shall comply with National Electrical Code and ASME Code.
   Noise level of chiller shall not exceed 65 DBA at 10 meters from the unit.
2. Compressor
   Compressor shall be semi- hermetic screw type and shall have an operating oil charge. Compressor shall be equipped with suction and discharge shutoff valves and be mounted on spring vibration isolators. Motor shall be direct drive cooled by suction gas passing around the windings and shall have over-temperature protection. Manual restart of unit shall be required after motor stoppage due to thermal overload or insufficient oil pressure. Each compressor shall be equipped with an internal discharge check valve to prevent rotor backspin upon shut-down. A contactor and a calibrated, manual-reset, ambient- insensitive overload protector shall be factory installed for each compressor motor. The protector shall open all 3 phases in the event of overload in any one phase.
3. Cooler
   Cooler shall be shell-and-tube, with removable heads. It shall have 2 direct-expansion refrigerant circuits. Seamless copper tubes shall be rolled into the tube sheets. Shell shall be protected against freeze-up by a layer of vapor barrier insulation and a heater cable wrapped helical around the shell, under the insulation. The fouling factor to the cooler shall not exceed 0.001.
   Refrigerant circuit components (factory supplied and piped) shall include hot gas muffler, high side pressure relief valve; liquid line shutoff valve ; filter-drier, moisture indicating sight glass ; liquid line solenoid valve; thermal expansion valve.
   Chilled water circuit shall include flow switch on the entering water to the cooler.

4. Air Cooled Condenser
   Condenser coils shall be corrosion resistant type.
   Tube shall be in copper and fins shall be in aluminum with corrosion protection.

Coils shall include a sub-cooling section and shall be designed for use with Refrigerant 407 C or Refrigerant 134 A.
Coil circuits shall be factory leak tested at 470 psig under water.

5. Condenser Fans and Motors
   The condenser section of each unit shall have propeller-type fans, with safety guards. Air discharge shall be upward.
   The propeller fans shall have weather resistant blades and shafts. Motor shall be permanently lubricated air over type. They have totally enclosed, drip proof for outside weather conditions, with built in over load protection.
   Low noise fans shall be selected, with multi-speed for night modes.
6. Head Pressure Control
   Each unit shall be capable of operating satisfactorily at low outdoor air temperatures.
7. Capacity Control
   Each unit shall be factory-equipped with an electrically-operated device for loading and unloading compressor cylinders and a control for cycling compressors.
   A minimum of three capacity steps shall be required on each chiller.
8. Control Box
   Controls shall be factory wired, in a weatherproof box, and shall include a positive acting timer to prevent short cycling of compressors and to delay restart of compressors after shutdown. The unit control-box shall also include high and low pressurestat ; multiple-step water temperature controller ; chilled water safety thermostat ; field power and control circuit terminal blocks ; circuit breakers, motor contactors ; control relays ; disconnect switch. On all units source of control circuit power shall be completely independent of the unit power source.
   The unit shall have a reduced starting current not exceeding 2 times the total running current of each chiller.
9. Vibration Isolators
   The compressor shall be mounted on rubber-in-shear vibration isolators to minimize vibration transmission to the rest of the machine. Also spring isolator shall be provided in accordance with manufacturers recommendations.

END SUCTION CENTRIFUGAL PUMP

Type: Horizontal, base mounted, end suction, single stage, centrifugal type, directly connected to motor through a heavy duty flexible coupling, with gauge coupling guard.
Base: Pump and motor to be mounted on common steel base adequately reinforced against deflection, with drip rim, drain tapping, bolt holes and grouting hole.
Bearings: pump rotating element to be supported by two heavy duty grease lubricated ball bearings mounted in heavy iron frame with adequate supports to base for maximum rigidity.
Pump casing: High tensile strength close grain cast iron with smooth waterways, register fitted and bolted to bearing frame for permanent alignment, with bronze wear rings and tapped and plugged bottom frain and top vent connections.
Impeller: bronze, enclosed type, fitted to shaft with key and locked in place.

Shaft: one piece stainless steel, sized to carry axial and radial thrust with minimum deflection.
Mechanical seal: Ni-resist face, carbon washer and stainless steel metal parts.
Electric motor: Totally enclosed, fan cooled, squirrel cage, induction type, with permanently lubricated and sealed ball bearings. Motor speed 1450 RPM.

Required accessories:
Each pump shall be installed with the following:

1. Gate valve, strainer, pressure gauge, and gauge cock at its suction.
2. Pressure gauge and gauge cock, check valve and gate valve at its discharge.
3. Vibration isolator mounting with flexible connections.

CLOSED EXPANSION TANK

Tank: Closed, cylindrical, welded, pressure vessel type, with fixed spherical ends, fabricated from high quality stainless steel plate for design working pressure of 10 bars (150 psi) at 110 deg. C. It is to be hydrostatically tested at factory to 1 1/2 times design working pressure.

Diaphragm: Tank to have rubber composition spherical diaphragm to prevent system water coming into contact with air cushion. Tank to be provided with means for easy removal of diaphragm for inspection and for inspecting inner wall of tank.

Accessories: Female threaded expansion line connection on bottom spherical end and appropriate air valve for field adjustment of cushion pressure to suit cold fill pressure.

Support: Provide adequate legs for floor mounting tank vertically.

Paint: Tank to be painted at factory with durable enamel paint on outside and with adequate treatment against corrosion on inside.

Provide check valve, pressure reducer, gate valves and bypass quick fill valve.

PLATE HEAT EXCHANGER

Heat exchanger to be plate type, stainless steel, working pressure 10 bars. The gasket shall withstand 100°C.

- Primary circuit: 6.5°C – 11.5°C.
- Secondary circuit: 7°C - 12°.

Provide thermometers for all the four connections.
Exchanger to be selected and fabricated for maximum efficiency (maximum 2% loss).

MOTOR CONTROL CENTER

The contractor shall provide motor control panel for the control of chillers and pumps with contactors, circuit breakers and indicator light for each unit functions.

Electrical contractor shall supply only:
Main power cable to the control panel and main power cable to the chillers.

All other power and control cables between chillers and pumps to be done by the mechanical contractor.

INSTALLATION

Examine Conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

Examine the Contract Drawings and specifications in order to insure the completeness of the

work required under this Section. Provide supplementary parts necessary to complete all insulation work, though not specifically indicated or specified herein.

Verify all measurements and dimensions at the job site and cooperate in the coordination and scheduling of the work of this section with the work of related trades, so as not to delay job progress.

Install cooling plant units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchor in locations indicated and maintain manufacturer's recommended clearances.

Install units on concrete pad, 4 inches larger on each side than equipment base.
Cast anchor bolt inserts into pad.

Electrical Wiring
Turn over to Electrical Contractor devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Contractor.
Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements. Do not proceed with equipment startup until wiring installation is acceptable to equipment manufacturer.

Coordinate with fire alarm to stop units during fire.

FIELD QUALITY CONTROL

Startup cooling plant units, in accordance with manufacturer's startup instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

SECTION 16 – FUEL SYSTEMS

GENERAL

Provide labor, materials, equipment and services, and perform operations required for complete installation of heating systems and related work as indicated on the drawings and specified herein.

Work Included: The work shall include, but not be limited the followings:
1. Fuel oil tanks.
2. Fuel oil pumps.
3. Provide factory-mounted and wired controls and electrical devices as specified.

QUALITY ASSURANCE

Materials shall conform to the latest edition of industry standards and reference specifications specified herein and to applicable codes and requirements of local authorities having jurisdiction, whichever is more stringent.

Tests: Test heating systems in accordance with the appropriate section of the specifications describing each system.

SUBMITTALS

Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights, furnished specialties and accessories and installation and startup instructions.

Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances and methods of assembly of components.

Wiring Diagrams: Submit manufacturer's electrical requirements for electronic control and power supply wiring to units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation of units and controls. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

Maintenance Data: Submit maintenance data and parts list for each packaged cooling only unit, control and accessory, including "troubleshooting" maintenance guide. Include this data and product data in maintenance manual.

DELIVERY, STORAGE AND HANDLING

Handle equipments and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged units or components; replace with new.

Store equipments and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.

Comply with manufacturer's rigging and installation instructions for unloading equipments, and moving units to final locations for installation.

WARRANTY

Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, motors and burners with inadequate and defective materials and workmanship, including leakage, breakage, improper assembly or failure to perform as required. Manufacturer's instructions for handling, installing, protecting and maintaining units must be adhered to during warranty period. Replacement includes component replacement and labor for removal, reinstallation and retesting and balancing.

Warranty Period: Two years from Date of Substantial Completion.

Contractor shall include separate service Contract for Labor, if required.

EQUIPMENTS

FUEL OIL TANK

Embedded fuel oil tanks to be cylindrical type black steel 5 mm thick, with top cover, gauge, fill and outlet connections (test pressure 3 bars).

Rectangular fuel oil tank to be 4 mm thick black steel with top cover, gauge, fill and outlet connections.

FUEL OIL GEAR PUMPS

Fuel oil pumps to be in line rotary gear type, two pumps one duty/one standby.

Pumps to be of the monoblock rotary gear type with suction and discharge connections screwed ANSI parallel thread. Casing and gears to be of cast iron construction with the drive shaft in high tensile steel. Pumps shall be spark proof.

The shaft shall be supported by PTFE impregnated carbon bearings, and sealed by either PTFE impregnated packing or carbon faced mechanical seal. The pumps shall be fitted with an integral relief valve for protection from excessive pressure.

The pump unit shall be close-coupled driven through a flexible coupling.

INSTALLATION

Examine Conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

Examine the Contract Drawings and specifications in order to insure the completeness of the work required under this Section. Provide supplementary parts necessary to complete all insulation work, though not specifically indicated or specified herein.

Verify all measurements and dimensions at the job site and cooperate in the coordination and scheduling of the work of this section with the work of related trades, so as not to delay job progress.

Install heating units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchor in locations indicated and maintain manufacturer's recommended clearances.

Electrical Wiring

Turn over to Electrical Contractor devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Contractor.

Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements. Do not proceed with equipment startup until wiring installation is acceptable to equipment manufacturer.

SECTION 17 - FAN COIL UNITS

GENERAL

Provide labor, materials, equipment and services, and perform operations required for complete installation of the fan coil units and related work as indicated on the drawings and specified herein.

Work Included: The work shall include, but not be limited to, the following:
1. Fan.
2. Coils.
3. Filters.
4. Thermostat.

Provide factory-mounted and wired controls and electrical devices as specified in this section.

QUALITY ASSURANCE

Materials shall conform to the latest edition of industry standards and reference specifications specified herein and to applicable codes and requirements of local authorities having jurisdiction, whichever is more stringent.

SUBMITTALS

Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights, furnished specialties and accessories and installation and startup instructions.

Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances and methods of assembly of components.

Wiring Diagrams: Submit manufacturer's electrical requirements for electronic control and power supply wiring to fan coil units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation of fan coil units and controls. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

Maintenance Data: Submit maintenance data and parts list for each fan coil unit, control and accessory, including "troubleshooting" maintenance guide. Include this data and product data in maintenance manual booklet.

DELIVERY, STORAGE AND HANDLING

Handle fan coil units and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged fan coil units or components; replace with new.

Store fan coil units and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.

Comply with manufacturer's rigging and installation instructions for unloading fan coil units, and moving units to final locations for installation.

WARRANTY

Warranty on Motor: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, motors with inadequate and defective materials and workmanship, including leakage, breakage, improper assembly or failure to perform as required. Manufacturer's instructions for handling, installing, protecting and maintaining units must be adhered to during warranty period. Replacement includes component replacement and labor for removal, reinstallation and retesting and balancing.
Warranty Period: Two years from Date of Substantial Completion.
Contractor shall include separate service Contract for Labor, if required.

MATERIALS

The contractor shall supply and install where shown on the plans fan coil units. Capacity and rating shall be as specified on the schedules and as indicated on the drawings. Units are to be ARI rated, and shall be of the ducted type with casing.
The fan and coil units shall be standard product factory assembled and tested complete with the following parts :
The unit shall be of the low noise type capable of supplying the specified flow at medium speed.

Casings shall be of sheet steel protected against corrosion and finished inside and outside with stove primer. All corners shall be rounded. Casings shall include space for pape work connections and valves, and there shall be ready access to the fan and motor, the filter, the damper, the drain pan and connections and valves.

Unit shall have one coil for chilled water (additional heating coil to be provided for 4 pipes units).
Coil shall be of a minimum of three row deep, staggered tube, plate fin with copper tube connections and fitted with automatic air vent and drain connections. Fan coil units shall be designed to permit right or left hand connections.
All units shall be provided with a drain pan to catch condensate from coil, fabricated of heavy gauge galvanized steel, and insulated with a minimum of 1/4" layer of insulating mastic with a softening point not less than 285°F; drain shall be pitched of 1/4" toward the drain hole.
Drain pan shall be extended from each side of fan coil unit.

Fan coil unit shall include one or more centrifugal type fan, forward curved, directly driven by a two-bearing motor of the shaded pole type, equipped with built in thermal overload protection.
Motors shall be quiet running and shall have sleeve bearings factory lubricated for life. Motor windings and electrical components shall be impregnated or protected to avoid trouble from condensation.

Air filters may be nylon fiber, glass fiber or cellular plastics material and shall have a minimum efficiency of 60% when tested in accordance with B.S. 2831 using Test Dust No 3. Filter to be of the throw away type. Filter thickness shall be at least 10 mm.

Each coil shall be fitted with valve package comprising one gate valve, one double regulating valve and one three way valve spring return, strainer, and dielectric connectors.
The thermostat and the speed selector shall be of the package type, model to be approved by the architect
The room thermostat shall incorporate a room temperature sensor with fan speed control switches.
Unit shall be with adjustable scale in °C from 10°C to 35 °C.

Castings shall be lined with material to act as both thermal and acoustic insulation. Fan and motor assemblies shall be complete with anti-vibration mountings.
Noise level shall not exceed 40 DBA measured at one meter from the unit. Also the noise level produced by the unit and measured at a distance of one meter from the air register shall not

exceed 35 DBA. In case the above figures are exceeded, sound absorbers or internal lining shall be installed.

INSTALLATION

Examine Conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

Examine the Contract Drawings and specifications in order to insure the completeness of the work required under this Section. Provide supplementary parts necessary to complete all insulation work, though not specifically indicated or specified herein.

Verify all measurements and dimensions at the job site and cooperate in the coordination and scheduling of the work of this section with the work of related trades, so as not to delay job progress.

Install fan coil cooling units in accordance with manufacturer's installation instructions.
Install units plumb and level, firmly anchor in locations indicated and maintain manufacturer's recommended clearances.

Electrical Wiring
Turn over to Electrical Contractor devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Contractor.
Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements. Do not proceed with equipment startup until wiring installation is acceptable to equipment manufacturer.

Ductwork
Connect supply and return ducts to unit with flexible duct connections. Provide transitions to exactly match unit duct connection size.

Drain Piping - Connect unit drain to nearest indirect waste connection. Provide trap at drain pan, construct at least 1 inch deeper than fan pressure in inches of water.

FIELD QUALITY CONTROL

Startup fan coil units in accordance with manufacturer's startup instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

SECTION 18 – AIR CONDITIONING UNITS

GENERAL

Provide labor, materials, equipment and services, and perform operations required for complete installation of direct expansion, heat pump, central ducted A/C units and mini split units and related works as indicated on the drawings and specified herein.

Work Included: The work shall include, but not be limited the followings:
1. Ducted type A/C split units heat pump.
2. Mini split units.
3. Provide factory-mounted and wired controls and electrical devices as specified in this section.

QUALITY ASSURANCE

Materials shall conform to the latest edition of industry standards and reference specifications specified herein and to applicable codes and requirements of local authorities having jurisdiction, whichever is more stringent.

SUBMITTALS

Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights, furnished specialties and accessories and installation and startup instructions.

Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances and methods of assembly of components.

Wiring Diagrams: Submit manufacturer's electrical requirements for electronic control and power supply wiring to A/C units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring required for final installation of units and controls. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.

Maintenance Data: Submit maintenance data and parts list for each A/C unit, control and accessory, including "troubleshooting" maintenance guide. Include this data and product data in operation and maintenance manual.

DELIVERY, STORAGE AND HANDLING

Handle equipments and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged units or components; replace with new.

Store equipments and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.

Comply with manufacturer's rigging and installation instructions for unloading equipments, and moving units to final locations for installation.

WARRANTY

Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, detectors valves and filter with inadequate and defective materials and workmanship, including leakage, breakage, improper assembly or failure to perform as required. Manufacturer's instructions for handling, installing, protecting and maintaining units must be adhered to during warranty period. Replacement includes component replacement and labor for removal, reinstallation and retesting and balancing.

Warranty Period: Two years from Date of Substantial Completion.

Contractor shall include separate service Contract for Labor, if required.

MATERIALS

DUCTED TYPE A/C, SPLIT UNIT, HEAT PUMP

The contractor shall supply and install A/C split units heat pump. Capacity and rating as shown on the schedules and as specified below. A/C units shall be suitable for long run application (above 35 meters run).
Indoor unit shall be constructed of galvanized steel heavy gauge cabinet and finished with a weather resistant paint.
The unit shall be draw through type.
Centrifugal fans shall be double inlet, multi-blade forward curved type. The fan rotor shall be statically and dynamically balanced to eliminate noise and vibration.
The fan shall be driven by a squirrel cage induction motor. Small capacity units shall have direct drive fans.
Permanently sealed pre-lubricated fan ball bearings shall be mounted on the unit.
The coil shall be of seamless copper tubing having helical wound aluminum fins or continuous aluminum plate fins across the entire coil width. Fins shall be firmly bonded to the tubes by means of mechanical expansion of the tubes and shall be so spaced as not to exceed 10 fins per inch. The coil shall be tested at not less than 250 psig. The face velocity shall not exceed 500 FPM.
The coil shall be accessible for service and cleaning and shall be removable without dismantling the entire unit and it shall be pitched inside the coil section to allow for proper drainage.
Filter shall be 1" thick. Filter shall be of the permanent, cleanable type and shall be in accordance with the requirements of this subdivision of the Specification. Filters shall be easily removable for cleaning.
Face velocity across filters shall not exceed 500 feet per minute unless otherwise specified.
Condensate drain pan with threaded drain connections, shall be completely insulated.
Drain pan shall be provided in each unit under both the fan and the coil section. Drain pans shall have drain connections on both sides and a deep seal trap.

Outdoor unit shall be constructed of mild steel, heavy gauge cabinet, Zink coated and finished with a weather resistant paint, suitable for sea atmosphere application.

Condenser coil shall be constructed of aluminium fins mechanically bonded to seamless copper tubes arranged in multiple flat rows.
Condenser fan to be propeller axial type silent type, up flow discharge direct driven, statically and dynamically balanced. Fan motor to be of the permanently lubricated type with thermal and current overload protection.

Compressor shall be of the hermetic scroll type inside sound proof housing, with overhead and overload protection. The compressor shall be isolated from the cabinet floor by rubber vibration isolators.
Compressor shall have a crank case heater, three phase failure and 3 phase rotational direction inversion detector and high / low voltage relays.

Compressor control shall include but not limited to the following:

- High pressure cutout.
- Low pressure cutout.
- Time delay on restart to eliminate short cycling.
- Contactor for compressor.
- Contactor for condenser fan.

Control shall be factory pre-wired designed for 24 Volts operation.
Three phase compressors shall be also equipped with field installed phase failure and phase inversion detector.

The condensing unit suction and liquid refrigerant lines shall terminate with shut-off valves for units larger or equal to 5 tons and with quick connect type connections for smaller units.
Circuits shall be field equipped with a filter dryer and sight glass.
Each unit shall be equipped with thermostatic expansion valve downstream condenser coil.

Each unit shall be fitted with room thermostat with ON-OFF-AUTO switch with temperature reading.
The thermostat shall be located as required by the Engineer.
The thermostat shall be of the package type and all the control panel shall be located as required by the engineer.

Electric power shall be supplied to the unit, contractor to supply and install electric power and control cables between unit and thermostats.
Cables shall be of NYH type according to electrical specifications with the required number of conductors.
The empty tubes (sleeves) and all control wires and devices power supply other than main unit to be installed by mechanical contractor.

Cooling coils selection data must be submitted with offer for approval.
All units shall meet the capacities as shown on drawings.
The evaporator fan shall deliver the capacities indicated against the internal static pressure (filter, coils, etc).

Fan and motor assemblies shall be complete with anti-vibration mountings.
Noise level shall not exceed 55 DBA measured at ten meters from the outdoor unit. Also the noise level produced by the unit and measured at a distance of one meter from the air register shall not exceed 35 DBA. In case the above figures are exceeded, sound absorbers shall be installed.
Air velocity through the coil shall not exceed 500 FPM.

DECORATIVE TYPE A/C, SPLIT UNIT, HEAT PUMP

The contractor shall supply and install A/C split units heat pump. Capacity and rating as shown on the schedules and as specified below.
Indoor unit shall be constructed of galvanized steel heavy gauge cabinet with PVC cover and grills.
Centrifugal fans shall be double inlet, multi-blade forward curved type. The fan rotor shall be statically and dynamically balanced to eliminate noise and vibration.
The fan shall be driven by a squirrel cage induction motor. Units shall have direct drive fans.
Permanently sealed pre-lubricated fan ball bearings shall be mounted on the unit.

The coil shall be of seamless copper tubing having helical wound aluminum fins or continuous aluminum plate fins across the entire coil width. Fins shall be firmly bonded to the tubes by means of mechanical expansion of the tubes and shall be so spaced as not to exceed 10 fins per inch. The coil shall be tested at not less than 250 psig.

Filter shall be 6 mm thick. Filter shall be of the permanent, cleanable type and shall be in accordance with the requirements of this subdivision of the Specification. Filters shall be easily removable for cleaning.

Condensate drain pan with threaded drain connections, shall be completely insulated.
Drain pan shall be provided in each unit under both the fan and the coil section.

Outdoor unit shall be constructed of mild steel, heavy gauge cabinet, zink coated and finished with a weather resistant paint, suitable for sea atmosphere application.

Condenser coil shall be constructed of aluminum fins mechanically bonded to seamless copper tubes arranged in multiple flat rows.
Condenser fan to be propeller axial type silent type, side discharge direct driven, statically and dynamically balanced. Fan to be of the permanently lubricated type with thermal and current overload protection.

Compressor shall be of the hermetic scroll type inside sound proof housing, with overhead and overload protection. The compressor shall be isolated from the cabinet floor by rubber vibration isolators. Compressor shall have high / low voltage relays.

Compressor control shall include but not limited to the following:
- High pressure cutout.
- Low pressure cutout.
- Time delay on restart to eliminate short cycling.
- Contactor for compressor.
- Contactor for condenser fan.

Control shall be factory pre-wired designed for 24 Volts operation.

The condensing unit suction and liquid refrigerant lines shall terminate with quick connect type connections.
Circuits shall be field equipped with a filter dryer and sight glass.
Each unit shall be equipped with capillary tubes expansion device downstream condenser.

Each unit shall be fitted with room remote thermostat with ON-OFF-AUTO switch with temperature reading on the unit.
The thermostat shall be located as required by the Engineer.
The thermostat shall be of the package type and all the control panel shall be located as required by the engineer.

Electric power shall be supplied to the unit, contractor to supply and install electric power and control cables between outdoor and indoor units.
Cables shall be of NYH type according to electrical specifications with the required number of conductors.
The empty tubes (sleeves) and all control wire and devices power supply other than main unit to be installed by mechanical contractor.

The noise level produced by the unit and measured at a distance of one meter from the air register shall not exceed 35 DBA.

INSTALLATION

Examine Conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

Examine the Contract Drawings and specifications in order to insure the completeness of the work required under this Section. Provide supplementary parts necessary to complete all insulation work, though not specifically indicated or specified herein.

Verify all measurements and dimensions at the job site and cooperate in the coordination and scheduling of the work of this section with the work of related trades, so as not to delay job progress.

Electrical Wiring
Turn over to Electrical Contractor devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Contractor.
Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements. Do not proceed with equipment startup until wiring installation is acceptable to equipment manufacturer.

All A/C units to be stopped during a fire (interconnection to fire alarm).

Ductwork
Connect supply and return ducts to unit with flexible duct connections. Provide transitions to exactly match unit duct connection size.

Connect unit drain to nearest indirect waste connection. Provide trap at drain pan, construct at least 1 inch deeper than fan pressure in inches of water.

FIELD QUALITY CONTROL

Startup package cooling units, in accordance with manufacturer's startup instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

SECTION 19 - FANS

GENERAL

Provide labor, materials, equipment and services, and perform operations required for complete installation of the fans and related work as indicated on the drawings and specified herein.

Work Included: The work shall include, but not be limited to fans.

QUALITY ASSURANCE

Materials shall conform to the latest edition of industry standards and reference specifications specified herein and to applicable codes and requirements of local authorities having jurisdiction, whichever is more stringent.

SUBMITTALS

Product Data: Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, weights, furnished specialties and accessories and installation and startup instructions.

Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances and methods of assembly of components.

Maintenance Data: Submit maintenance data and spare part lists. Include this data, product data and shop drawings in maintenance manual.

DELIVERY, STORAGE AND HANDLING

Handle fans and components carefully to prevent damage, breaking, denting and scoring. Do not install damaged fans or components; replace with new.

Store fans and components in clean dry place. Protect from weather, dirt, fumes, water, construction debris and physical damage.

CENTRIFUGAL FANS

Supply and install all centrifugal fans wherever shown on the drawings and as specified herein.
Fan shall be centrifugal, silent duct fan type, with wheel statically and dynamically balanced.
Motor shall be totally enclosed maximum speed 1450 rpm, permanently lubricated type with built-in overload protection.
Housing shall be galvanized steel.
Fan shall be supplied complete with fan controller with indicating light and necessary supports.

Fan shall be equipped with:
a. Flexible canvas connections connecting fan with associated ductwork.
b. Vibration isolation structural steel base with spring isolators and supports.
c. Filters for fresh air fans.

Capacity and type of each centrifugal fan shall be as given in drawings or in the Bills of Quantities.

INSTALLATION

Examine Conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

Examine the Contract Drawings and specifications in order to insure the completeness of the work required under this Section. Provide supplementary parts necessary to complete all fan installation, though not specifically indicated or specified herein.

Verify all measurements and dimensions at the job site and cooperate in the coordination and scheduling of the work of this section with the work of related trades, so as not to delay job progress.

Install fans in accordance with manufacturer's installation instructions.

Electrical Wiring
Turn over to Electrical Contractor devices furnished by manufacturer but not specified to be factory-mounted. Furnish copy of manufacturer's wiring diagram submittal to Electrical Contractor.
Verify that electrical wiring installation is in accordance with manufacturer's submittal and installation requirements. Do not proceed with equipment startup until wiring installation is acceptable to equipment manufacturer.

FIELD QUALITY CONTROL

Startup fans in accordance with manufacturer's startup instructions.

SECTION 20 - GRILLS AND DIFFUSERS

GENERAL

Provide all labor, materials, equipment and services, and perform all operations required for complete installation of the Air Outlets and Inlets and related work as indicated and specified herein.

Work Included: The work shall include, but not be limited to, the following:
1. Diffusers.
2. Grills.
3. Louvers.

QUALITY ASSURANCE

Codes and Standards
ARI compliance - Test and rate air outlets and inlets in accordance with ARI 650 "Standard for Air Outlets and Inlets".

ASHRAE Compliance - Test and rate air outlets and inlets in accordance with ASHRAE 70 "Method of Testing for Rating the Air Flow Performance of Outlets and Inlets".

SUBMITTALS

Product Data: Submit manufacturer's technical product data for air outlets and inlets including:

Data sheet for each type of air outlet and inlet, and accessories furnished, indicate materials of construction, finish, mounting details and method of assembly of components. Mark data with specification type.

Shop Drawings:
1. Shop drawings of diffusers, registers and grilles must include complete schedule for each diffuser outlet type indicating drawing designation, room location, number furnished, model number, size and accessories furnished. Mark data with specification type.
2. In all cases, prepare and submit a schedule of grilles, diffuses and registers to the Engineer for approval of size and design of outlets before ordering for installation.
3. Submit samples for approval where required by Engineer and three samples of each type of finish furnished.

Maintenance Data: Submit maintenance data including cleaning instructions for finishes, and spare parts lists. Include this data, product data, and shop drawings in maintenance manual.

DELIVERY, STORAGE AND HANDLING

Deliver air outlets and inlets wrapped in factory-fabricated containers. Identify on outside of container type of outlet or inlet and installation location. Avoid crushing or bending and prevent dirt and debris from entering and settling in devices.

Store air outlets and inlets in original cartons and protect from weather and construction work traffic. Where possible, store indoors. When necessary to store outdoors, store above grade and enclose with waterproof wrapping.

MATERIAL

GENERAL

Provide all grilles, diffusers, ceiling return inlets, exhaust grilles, etc., as shown and noted on the drawings. Models shall be approved by the Engineer and shall be selected carefully so as to permit good air distribution inside the air conditioned space and keep air motion and noise within acceptable limit.
The fixing of grilles and diffusers to the ductwork shall be by means of spring. External screws will not be accepted.
All grilles and diffusers to be factory enamel painted, color to be approved.
The final selection of grilles and diffusers must be checked by the contractor for proper throw at actual installation conditions.

FIXED BLADE EXHAUST GRILLS

Fixed blade grills shall be of heavy gauge extruded aluminum construction mechanically assembled and anodized.
Grills shall be provided with volume control dampers.

LINEAR GRILL OR DIFFUSER

Linear grill shall be aluminum, heavy gauge fixed blade, bar type, 1/2" spacing, with volume control dampers on supply opening.
Linear diffuser shall be aluminum, heavy gauge, slot type 3/4" wide, with volume control dampers on supply opening.

SUPPLY AND RETURN WALL GRILLS

Supply and return wall grills shall be aluminum, heavy gauge, double deflection, rotating blades, with volume control dampers on supply opening, adjusted by screw fixed inside the grill.

CEILING SQUARE DIFFUSERS

Ceiling square diffusers shall be of heavy gauge extruded aluminum construction mechanically assembled and anodized.
Diffusers shall be provided with volume control dampers adjustable from the front of the diffuser.

EXTERNAL LOUVERS

All louvers for fresh air and exhaust air shall be fabricated from heavy duty aluminum extrusions. The horizontal blades shall be angle down towards the front of the louvers and each blade shall have a down turn at the front and up turn at the back edges in such a manner that the ingress of rain is prevented. Each blade shall be securely fixed to the surrounding frame.
All louvers shall be fitted with an aluminum bird wire screen on the inside face.

DOOR GRILLS OR TRANSFER GRILLS

Each door grille shall be square or rectangle shape and complete with :
1. Inverted “V” or “Y” fixed type horizontal blades .

2. Fixing frame for outlet mounting on doors or walls on both sides. Frame may be of wood or metallic construction as site conditions dictate.
3. All necessary supports and fixing accessories.
4. Fire dampers where required.

Door grilles shall be installed with bottom at a uniform height of 40 cm above floor level.

INSTALLATION

Examine conditions at the job site where work of this section is to be performed to insure proper arrangement and fit of the work. Start of work implies acceptance of job site conditions.

Examine the Contract Drawings and specifications in order to insure the completeness of the work required under this Section.

Verify all measurements and dimensions at the job site and cooperate in the coordination and scheduling of the work of this section with the work of related trades, so as not to delay job progress.

Install air outlets and inlets in accordance with manufacturer written instructions and in accordance with recognized industry practices to insure that products serve intended functions. Coordinate with other work, including ductwork and duct accessories, lighting, structural and Architectural elements, as necessary to interface installation of air outlets and inlets with other work.
Locate ceiling air diffusers, registers, and grilles, as indicated on general construction "Reflected Ceiling Plans" or as approved by Engineer.

Diffuse supply air to assure air velocities not in excess of 50 fpm at 6 feet or less above the floor line. Mix room air with the primary air by induction to effect subsequent equalization of the room temperature without stratification. Install all outlets in accordance with manufacturer's recommendations.

Outlets shall comply with applicable noise criteria specifications.

Colors of grilles and diffusers shall be decided by the Architect.

SECTION 21 – ELECTRICAL WORKS FOR MECHANICAL SYSTEMS

GENERAL

Provide all labor, materials, equipment and services, and perform all operations required for complete installation of electrical works related to mechanical systems as indicated on the drawings and as specified herein.

Work Included: The work shall include, but not be limited to, the following:

1. Motor control centers, motor control panels for each item or system and housing all protection gear, switches and controls required for the specified function.
2. All cables and wires between equipment and the corresponding motor control center or motor control panel.
3. All electrical equipment, wiring, cables, conduits, boxes, earth connections, control switches, starters, circuit breakers, isolating switches, relays, contactors, protective gear or equipment, transformers, etc… and other necessary item or components required for the satisfactory operation, control and protection of the systems.

QUALITY ASSURANCE

Electrical works shall comply with the following standards:
- ANSI, NEMA, BS, VDE, DIN, IEC, UTE.

All electrical equipments, materials, accessories, etc… to be supplied for the mechanical systems, as well as all electrical works and tests to be done shall confirm also with the requirements of the relevant specifications for the electrical systems.

SUBMITTALS

Product Data: Submit names of manufacturer's and copies of latest published literature including types, applications for materials herein for approval; obtain write approval before ordering materials.

Submittal shop drawings including all technical Data, all wiring diagrams, breakers rating and all related installations.

PRODUCT

GENERALITIES

Power supply connections to vibrating or rotating machinery shall be made through adequate metallic flexible conduits or tubings through which cables and wires shall be drawn.

Power and control wiring to run in separate conduits unless otherwise specified.

Conduits are to be supported with conduit supports in an adequate approved manner.

Circuits to be protected with high rupturing capacity fuses or circuit breakers.
Auxiliary supply for controls, other than from main power circuits, to be effectively isolated by auxiliary contacts on main isolator.

Motors to be earthed by connecting green insulated conductor from earthing bushing in starter to motor frame. Run earth conductor together with circuit wiring and terminate in motor terminal

box, provided earth terminal in box is connected to motor frame. If this is not feasible, extend earth conductor through insulated bushed opening in terminal box and connect to motor base.

Detailed wiring diagram is to be fixed inside each starter enclosure cover to clearly indicate circuits.

Circuit breakers earth fault detection and interruption are to be coordinated with those of main incoming breakers on main distribution panel.

Cables shall be color coded for identification.

CONDUITS, WIRES AND CABLES

Refer to electrical specifications for conduits materials, fire rating and installations.

Refer to electrical specifications for wires and cables, related to all mechanical equipments including cables related to fire pumps.

ELECTRIC MOTORS

Motors are to be supplied by driven equipment manufacturer to be as specified for equipment concerned and specifically supplied for available supply voltage and frequency.

Motors to be totally enclosed, fan cooled type, unless otherwise specified.

Motors are to have at least Class B insulation with 80 deg. C continuous temperature rise above average ambient temperature of 40 deg. C, unless otherwise specified, or otherwise indicated in the B.O.Q. (pumps motors to be Class F insulation).

Motors that will operate outdoors are to have Class F insulation.

Motors to be rated for continuous operation.

Power to be adequate to operate driven equipment without motor overload under all operating conditions and loads and throughout capacity range of equipment. Motor to be capable of delivering full rated output when operating at voltage deviating by 10% from rated voltage at rated frequency or at frequency deviation of a 5% at rated voltage.

Starting and torque characteristics to be as required by driven equipment.

Speed to be as specified for equipment concerned.

Conduit terminal box on motor to be approved model for type of motor enclosure.
Motor windings to be connected to terminals in terminal box at factory. One additional earthing terminal to be connected to motor frame.

Motor base to be adjustable where motors are directly connected to driven equipment, unless otherwise specified. Motors connected to equipment through V-belt drive to have adjustable sliding base. Fractional horsepower motors to have slotted mounting holes in base.

STARTERS

Starters for three phase motors to be magnetic type to automatically disconnect motor from power supply in case of supply failure, excessive voltage drop, overcurrent and lack of balance in phases. Overload trips to be provided for three phases.

Motor Data is to be obtained from equipment supplier before ordering any motor starter, or motor nameplate checked for full load current rating and allowable temperature rise in order to select proper overload thermal element for motor starter.

Short circuit protection device fitted to starter to be independent of controller and overload protection.

Control for starters and control circuits is not to exceed 110 V.

Step down control circuit transformers to be two winding isolating type.

Control circuit protection to be high rupturing capacity fuses or circuit breakers.

Starter for single phase motors to be surface or flush mounted, direct on line with low/high voltage protection.

Starter for three phase motors not exceeding 10 HP to be direct on line, non-reversing, magnetic type, with manual reset, and low/high voltage protection.

Starter for three phase motors over 10 HP but not exceeding 50 HP, to be automatic star delta magnetic non-reversing type, with adjustable low/high voltage relay.

Starter type D for three phase motors over 50 HP to be multiple step auto transformer non-reversing magnetic type, with adjustable low/high voltage relay, and earth leakage relay and with unbalanced current protection.

ISOLATING SWITCHES, PUSH BOTTOMS, RELAYS AND CIRCUITS BREAKERS

Refer to electrical specifications for isolating switches, push bottoms, relays and circuits breakers as well as for combination starters and isolating switches.

MOTOR CONTROL CENTER

Motor control center to be totally enclosed freestanding sectional type, with sections to form one assembly.

Construction to be at least 2 mm thick hot dip galvanized sheet steel, adequately reinforced and braced for maximum rigidity, sand blasted, rust inhibited after fabrication and sprayed with one coat primer and two coats enamel internally and externally.

Motor control center to include the following:

1. Main incoming circuit breaker.
2. Main copper busbars rated as main incoming circuit breaker.
3. Branch copper busbars of adequate capacity to distribute power to each circuit breaker and starter served.
4. Neutral copper busbar rated at least half capacity of main busbar and distributed throughout whole motor control center.
5. Earth copper busbars minimum 25 x 6 mm extending full length of motor control center.
6. One voltmeter with commutator range 0-415 V.
7. Ammeters on main supply with necessary current transformers.
8. Starters, circuit breakers, push bottoms, indicating lights, switches, relays, contactors and accessories as shown on the drawings.
9. Interconnecting and interlock wiring.

10. Refer to electrical specifications and drawings related to MCC for extra components and for more specific requirements.

Compartment doors to be interlocked so that isolators or breakers must be in OFF position before door can be opened.

Provide extra spare positions with fully equipped cells.

Starters, switches, other components and electrical devices to be clearly labeled.
Labels to be permanently fixed under each component.

Schematic and wiring diagrams to be firmly fixed within motor control center, showing each component and cross – referenced with component labels.

MOTOR CONTROL PANELS AND BOXES

Motor control panels and unit boxes to be wall mounted lockable type.

Construction to be minimum 1.5 mm thick hot-dip galvanized steel sheet, finished with one coat etch primer and one coat stove enamel internally and externally.

Panels installed outdoors to have weatherproof totally sealed water and dustproof enclosures.

Schematic and wiring diagrams to be mounted in permanent approved manner on inside of panel door. Diagrams are to show each component cross referenced with component labels. Labels to be permanently fixed under each components.

INSTALLATION

All electrical works to be installed by skilled laborers according to electrical engineer requirements.
To follow electrical specifications for testing, start-up of all electrical works related to mechanical systems.

SECTION 22 - TESTING, ADJUSTING AND BALANCING OF MECHANICAL SYSTEMS

GENERAL

Provide labor, materials, equipment and services, and perform operations required for complete Testing, Adjusting and Balancing of Mechanical Systems and related work as indicated on the drawings and as specified herein.
Testing and commissioning forms shall be submitted for approval before filled by contractor.
Work Included: The work of this section shall include, but not be limited to, the following:

1. Perform balancing of air and water distribution/circulating systems, and air outlets etc. for HVAC systems.
2. Installing Contractor shall furnish testing, adjusting and balancing labor, including standby electrician, materials, instruments and power required for testing.
3. Test equipment and systems which normally operate during certain seasons of the year during the appropriate season. Perform tests on individual equipment, systems and their controls. Whenever the equipment or system under test is interrelated and depends upon the operation of other equipment, systems and controls for proper performance, the latter shall be operated simultaneously with the equipment or system being tested.
4. Completely balance fans and duct systems by the adjustment, dampers, registers and other volume and diverting control devices, to obtain the air quantities indicated on the design drawings.
5. Completely balance piping systems by the adjustment of plug cocks, globe valves or other control devices to obtain flow quantities indicated on the design drawings. Installing Contractor shall replace or have pump manufacturer machine impeller the proper diameter to produce field design conditions.
6. Perform balancing of air distribution systems and adjusting of terminal devices, including:
   a. Adjust and set dampers, deflecting vanes, discharge vanes and accessories to achieve proper air distribution and patterns in the supply and exhaust air systems including terminal devices.
   b. Adjust and set belt driven fans to achieve design total delivered air quantities.
   c. Perform air distribution duct systems leakage tests.
7. Inspect the function and verify the operation of temperature control devices associated with the equipment and systems being balanced. Note deviations from specification requirements.
8. Check installation of vibration isolators and test for design ratings.
9. Prepare and submit reports and other data as specified.
10. Provide instruments required for testing, adjusting and balancing operations. Retain possession of instruments and remove from site at completion of services.

QUALITY ASSURANCE

Submit proof of having balanced and tested at least 2 projects.
The work performed by Balancing Contractor shall be under the direct supervision of a Registered Professional Engineer, a full-time employee of the Balancing Contractors which must be approved by the Employer and the Engineer. Technicians performing the work must be properly trained, experienced and full-time employees of Balancing Contractor.
Air Distribution Duct Leakage Test Verification

1. Smoke test to be followed for duct leakage test.
2. Installing Contractor shall perform leakage tests on duct systems. Verify and record the results of each test on standard test forms and submit copies of same to the Engineer for review.
3. Mark tested sections of ductwork with the date and initials of the balancing technician. Perform tests before duct sections are concealed and before systems are balanced.
4. Verify and record the results of leakage tests, both successful and unsuccessful.

SUBMITTALS

Submit copies of documentation to confirm compliance with Quality Assurance provisions:
1. Organization supervisor and personnel training and qualifications.
2. Specimen copy of each of the report forms proposed for use.

At least 15 days prior to starting field work, submit copies of a complete list of instruments proposed to be used, organized in appropriate categories, with data sheets for each, showing:
1. Manufacturer and model number.
2. Description and use when needed to further identify the instrument.
3. Size or capacity range.
4. Latest calibration date.

Engineer will review submittals for compliance with Contract Documents, and will return one set marked to indicate:
1. Discrepancies noted between data shown and Contract Documents.
2. Additional, or more accurate, instruments required.
3. Requests for re-calibration of specific instruments.

Submit copies of written reports tri-monthly, during the course of construction, of potential or developing problems and delays relating to the work being provided where such problems may adversely affect the proper balancing of the equipment or systems. The last report shall be no later than 1 week before testing work is to begin.

Submit written reports for review upon completion of each major phase of balancing work.

Submit reports of delayed testing promptly after execution of those services.

Form of Final Reports
1. Each final reporting form must bear the signature of the person who recorded data and the seal and signature of the TAB supervisor of the reporting organization.
2. Identify instruments used, and last date of calibration of each.
3. Submit final balancing report in accordance with requirements specified herein, modified and expanded to be compatible with the requirements of the installed systems.

JOB CONDITIONS

Procedures
1. Report and review the requirements of the work with Engineer before starting any field balancing work.
2. Periodically visit the site, at a maximum of three month intervals, during installation of the work. Should any potential or developing problems be discovered relating to materials, equipment or methods being used in the work, and where such problems may adversely affect the testing and adjusting work, immediately report these findings in writing to the Engineer with recommendations for correction.

Testing adjusting and balancing preparations

Before the testing adjusting and balancing Contractor performs the final testing, adjusting and balancing work, the Installing Contractor shall verify the following:
1. Ductwork systems are completely and satisfactorily installed and leak tested.
2. Piping systems are completely and satisfactorily installed and leak tested.
3. Equipment and apparatus fulfill the requirements of the Specifications and that equipment has been properly installed and checked for proper operating characteristics such as proper rotation and running amperage of fan and pump motors to prevent damage to equipment by overload.
4. Systems have been completely installed and operating and the automatic temperature controls have had their final adjustments.
5. New, clean filters have been installed in required systems.
6. Water systems have been completely filled and vented, and strainers cleaned proper to balancing, and that expansion tanks are at prior water level and makeup water valves are operating properly.

Coordination and Cooperation

1. Enlist the aid of Installing Contractors or equipment suppliers, at no cost to Employer, whenever such aid is necessary for the timely and proper performance of the testing and balancing work.
2. Cooperate with Installing Contractors to effect smooth coordination of the balancing work with the project schedule.

WARRANTY

After completion of the work specified under this Section, provide an extended warranty encompassing two full heating season and two full cooling season, during which time any balancing device which had been adjusted earlier as part of this work shall be rechecked and reset when such additional work is deemed necessary by the Employer or the Engineer.

EXECUTION

GENERAL REQUIREMENTS

All works shall be inspected during erection and upon completion according to the directions of the Engineer.
All systems shall be thoroughly cleaned both externally and internally before tests are performed.
All tests shall be made before systems are painted covered or enclosed in building construction whenever conditions permit.
When so directed by the Engineer, sections of the installations shall be blanked off so that they can be tested separately under suitable pressure.
The Contractor shall supply the skilled staff and all necessary instruments and carry out any tests of any kind on a piece of equipment, part of system or on a complete system if the Engineer requests such a test for determining specified or guarantee data, as given in the Specifications.
Any damage resulting from the tests shall be repaired and/or damaged material replaced, all to the satisfaction of the Engineer and at no additional cost.
In the event of any repair or any adjustment having to be made, other than normal running adjustment, the tests shall be void and shall be redone after the adjustment or repair have been completed.
Tests shall be performed in the presence of the Engineer and such other parties as may have legal jurisdiction.
In general, pressure tests shall be applied to piping only, before connection of equipment and appliances. In no case shall piping, equipment or appliances be subjected to pressure exceeding their rating.
When all pressure tests of piping have been performed, a discharge test shall be carried out for each group at the normal operating pressure.
After tests have been completed, the system shall be drained and cleaned of all dust and foreign matter. All strainers, valves and fittings shall be cleaned of all dirt, fillings and debris.

WATER PIPING TESTS

Leaks and Mechanical Resistance Test

Water piping shall be tested for the whole building.
All openings shall be vented and plugged, then subjected to pressure equivalent to one and a half times the maximum operating pressure.
The pressure must be maintained in the piping system at least twenty four (24) hours.
Any pressure drop will mean improper and defective installation.
A test under pressure equivalent to the maximum effective pressure and maintained over a period of twelve (12) hours shall be carried out after several opening and closing of valves and cocks to detect leaking valves or cocks.

Flow Test
After the leaks and mechanical tests, the Contractor shall test all the sanitary fixtures connected to the pipes at full load according to the instructions of the Engineer.

After testing, water system to be flushed and drained (twice).

INTERIOR DRAINAGE TEST

After completion of the installation related to the main stack for each floor, the connection openings together with the lower end of the stack shall be plugged and filled with clean water for a height of at least 3 meters above the tested joint, and the line inspected for any visible leaks.
The water must remain without any dropping level for at least 8 hours and any such drop will mean improper and defective installation.
The Contractor may perform the test after the complete installation of the sanitary piping. In this case, tee connections must be introduced on the stack at each floor interval in order to make it easy to plug the stack for testing purposes.

WATER HANDLING SYSTEMS

Before flow testing, water handling system to be flushed and drained (twice), disinfected by chemical feeders as requested by the engineer.
Circulating pump and motor speeds and pump suction and discharge heads for chilled water system.
The water quantity handled by each main pump.
Flow and return water temperature at all main equipment.
After testing, dosing pumps, to be installed for additional chemical feeders in run seasons.

CHILLERS

The following items shall be checked and /or tested :
Water flow and return temperature
Condensing and suction temperature
Power consumption and controller functioning

TANKS AND VESSELS

All tanks and vessels shall be tested for leaks under hydrostatic pressure equal to at least 1 1/2 times the specified working pressure, unless noted otherwise. Pipes tests procedures shall apply to the tanks and vessels.

FANS

Fans shall be tested for actual C.F.M. against design C.F.M. for actual R.P.M. , B.H.P. and electric power consumption .

FAN COIL UNITS AND AIR HANDLING UNITS

Each unit shall be tested for actual C.F.M., electric power consumption, R.P.M. and air and water temperatures required .

AIR OUTLETS

All air outlets shall be tested for actual C.F.M. against design C.F.M.

CONTROLS

All controls shall be tested for proper functioning in accordance with the requirements of the specifications

A/C SYSTEM TEST

After the installation of the systems is completed, the Contractor shall operate the systems for the time required to complete the necessary cooling and heating tests to demonstrate performance in accordance with design requirements .
The dates of commencement of the above operations shall be subject to agreement with the Engineer
In general, the cooling efficiency test must be carried out in the third quarter of the year while the heating test must be carried out in winter season .
The initial operation of the systems shall not constitute their acceptance. The final acceptance shall be made after the Contractor has repaired or replaced defective work, made all adjustments and fully demonstrated that the systems fulfill the design performance requirements to the entire satisfaction of the Engineer.