AFRICAN DEVELOPMENT BANK
SUDAN RELOCATION AND OUTFITTING PROJECT
SPECIFICATION VOLUME VIII
## Civil Works Specifications

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PART 1 – GENERAL

1.1 DESCRIPTION

A. Work Included:

This Section includes masonry mortar as necessary to properly bond all masonry units and construction and for cement parging on subgrade beams.

B. Related work specified elsewhere

1. Section 04200 Unit Masonry
2. Section 04510 Masonry Cleaning

1.2 SUBMITTALS

A. Samples of Mortar:

Indicating range of colors and textures shall be submitted with the masonry unit samples for review. The accepted sample shall then be used in all masonry sample panels specified other sections Masonry Unit and shall be a standard of comparison for the Project.

B. Product data:

Design mix reports for each type of mortar used include description of contents and proportions, and results of tests.
PART 2 – PRODUCTS

2.1 MATERIALS

A. Cementitious Materials shall be new, clean, loose, and dry. Do not change source of brands during the course of work.
   Use Portland Cement: SAS0-SSA-143 and ASTM-C150

B. Mortar Colors: Color pigments shall be natural, pure mineral pigments, chemically inert, unfading, and resistant to solvents, and with the exception of carbon black, shall not exceed 10% by weight of the cement content. Carbon black shall be limited to 3% by weight of the cement content. Water soluble matter shall not exceed 1%. Mortar when used with tiles, shall have same color as tiles.

C. Water for mixing and curing shall be free from oil and contain no more than 1500 ppm of chlorides as CL nor more than 1500 ppm of sulphates as SO4. Further the water shall not contain any impurities which will cause discoloration or etching concrete.

D. Mortar Aggregates (Sand) shall be clean, natural colored sand conforming to ASTM C144, except for joints less than 6.35 mm, use aggregate graded with 100% passing the No. 16 sieve. Aggregates for grout in reinforced masonry shall conform to ASTM C 404.

E. Mortar and Grout for Use in Reinforced Masonry: ASTM C 476.

2.2 PROPORTIONING

A. Proportioning for Mortar and Grout shall be within the limits given for each type specified. Proportions by volume are as follows:

   1. Type S1-part Portland Cement, 1/4 to 1/2 parts Hydrated Lime and 2 3/4 to 4 1/2 parts clean sand.
   2. Type O1-part Portland Cement, 1 1/4 to 2 1/2 parts Hydrated Lime, and 5 to 10 1/2 parts clean sand.
   3. Grout1-part Portland Cement, not more than 1/10 part Hydrated Lime, and 3 to 4-parts clean fine sand for fine grout, or: 2 to 3-parts fine sand and 1 to 2-parts coarse sand. (In no case shall the sum of the volume of fine and coarse sand exceed 4 times the sum of the separate volume of cement and lime used).

B. Proportioning for Cement Parging shall be within the limits given for each type specified. Proportions by volume are as follows:

   1. Parging:1 part Portland Cement and 3-1/2 parts clean sand, or: Type M mortar.
PART 3 – EXECUTION

3.1 INSTALLATION OF MORTAR AND GROUT

A. General: Laying mortar and grout, joints, tooling, etc., shall be performed in accordance with Section 04200 - Concrete Unit Masonry.

B. Mixing: All cementitious materials and aggregate shall be mixed for at least 3-minutes and not more than 5-minutes in a mechanical batch mixer, with the maximum amount of water to produce a workable consistency. After the initial mixing, the mortar shall be kept tampered; and water as required so that the mortar will contain the maximum amount of water consistent with good workability. All mortar shall be used within 2 1/2-hours after initial mixing.

C. Type S Mortar shall be used for all exterior masonry work, loadbearing masonry, reinforced masonry, and all other locations not specifically listed below.

D. Type O Mortar may be used for general interior use in nonload-bearing masonry construction.

E. Grouting: Use fine grout for filling spaces less than 100 mm in both horizontal and vertical directions and coarse grout to fill spaces 100 mm or larger. Remove dust, dirt, mortar droppings, loose masonry and other foreign materials from grout spaces.

End of Section 04100
SPECIFICATION SECTION 04200
UNIT MASONRY

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PART 3 EXECUTION
3.1 Installation of Mortar and Grout
3.2 Repair, Pointing and Cleaning
3.3 Curing
1.1 SECTION INCLUDES
A. Concrete unit masonry and related accessories for walls and partitions indicated on Drawings.

1.2 SUBMITTALS
A. Product Data: Submit manufacturer's product data, including laboratory test reports for each type of concrete masonry unit, accessories and other manufactured products, as well as certifications of compliance with the specified requirements for each type.
B. Shop Drawings: Submit cutting and setting drawings for units showing sizes, profiles and locations of each unit required.
C. Samples: Submit concrete unit masonry samples showing color and texture as well as ties and anchors for the Engineer selection and approval.

1.3 TRANSPORTATION, HANDLING AND STORAGE
A. Deliver masonry materials to site in an undamaged condition marked with name of manufacturer and identification of contents. Store masonry materials under waterproof covers on planking clear of ground and protected from damage, dirt, stain, water and wind.

1.4 QUALITY ASSURANCE
A. Engage a commercial testing laboratory approved by the Engineer to perform tests as specified below at no extra cost to Owner. Submit information regarding testing laboratory and qualifications of technical personnel to the Engineer for approval.
B. Tests: Testing laboratory shall test mortar materials, mortar and masonry panels as specified. Certified test reports shall identify materials by type, brand name and manufacturer and/or by origin. Use no mortar materials until laboratory test reports are approved by the Engineer. After tests have been made and materials approved, no changes shall be made without additional test and approval of the Engineer.
C. Testing: Materials proposed for use shall be tested for compliance with specifications in accordance with test methods contained in the referenced specifications and as follows:
1. Mortar: Test for compressive strength and water retention. Mortar shall have a compressive strengths at 7 days and 28 days as follows:
   a. MPa at 7 days.
   b. 5.17 MPa at 28 days.
2. Concrete Unit Masonry: Test for compressive strength, weight and water absorption and minimum compressive strength will be 50 kg/cm² at 28 days.
D. Mock-Up: Before starting masonry work, construct sample panel 3 m long by 2 m high for the Engineer's approval.
1.5 JOB CONDITIONS

A. Protect partially completed masonry against weather, when work is not in progress, by covering top of walls with strong, waterproof, non-staining membrane. Extend membrane at least 600 mm down both sides of walls and anchor securely in place.
PART 2 – PRODUCTS

2.1 MATERIALS

A. Concrete Unit Masonry:

1. Manufacturer: Obtain concrete masonry units from one manufacturer, of uniform texture and colour for each kind required for each continuous area and visually related areas.

2. Hollow Concrete Unit Masonry: Conform to SSA 87, SSA 144, 145 or ASTM C 90, Grade N, Type 1 and shall be of regular standard nominal sizes not less than 400 x 200 mm with standard widths as shown on the Drawings with permissible variations in dimensions of individual units not more than plus or minus 4 mm. Minimum thickness of face shell (FST)/web (WT) shall be 35 and 29 mm, respectively. Provide units with a compressive strength at 28 days not less than 7 Mpa, oven-dried weight (concrete) over 2000 kg/m³ and water absorption of maximum 25 percent by weight for individual block. Provide half units for ends non loading having density of 1000 kg/m³.

3. Special Shapes: Provide where shown and where required for lintels, corners, jambs, sash, control joints, and other special requirements.

4. Exposed Face: Provide manufacturer's standard colour and texture unless otherwise indicated.

5. Field Testing: Tests of concrete masonry units shall be completed in accordance with ASTM C 140 prior to installation of masonry.

B. Mortar and Grout Materials

1. Portland Cement: ASTM C 150, Type I. Provide natural colour or white cement as required to produce the required mortar colour.

2. Hydrated Lime: ASTM C 207, Type S.

3. Sand (for Mortar): ASTM C 144, except for joints less than 6 mm use aggregate graded with 100 percent passing the No. 16 sieve.

4. Fine Grout: Consist of fine aggregate conforming to ASTM C 404, size No. 1. Use fine grout in cells containing pipes and conduits.

5. Coarse Grout: Consist of fine and coarse aggregates conforming to ASTM C 404, size No. 89.


C. Mortar and Grout Mixes

1. Measurement: Use methods which will ensure that required proportions are controlled and accurately maintained. Measure aggregate materials in a damp, loose condition.

2. Mortar: Comply with ASTM C 270, Type N for interior and Type S for exterior.

3. Grout: Comply with ASTM C 476; grout to be used in cores where reinforcements are placed.

4. Mixing: Combine and mix cement, lime, water, and aggregates for a minimum of 5 minutes in a mechanical batch mixer.

5. Do not add air-entraining agents or other admixtures to mortar or grout materials unless otherwise indicated on Drawings or instructed by the Engineer.

6. Do not use calcium chloride in mortar or grout.
D. **Reinforcing Bars**

Reinforcing bars shall conform to ASTM A 615, Grade 60, deformed; sizes as indicated on Drawings.

E. **Masonry Accessories**

1. Joint Reinforcement and Ties for Masonry:
   a. Provide welded wire units from cold-drawn steel wire complying with ASTM A 82, with deformed continuous side rods and plain cross-rods, and a unit width of 38 mm to 50 mm less than thickness of wall or portion. Reinforcement shall be hot-dip galvanized after fabrication with 22 grams zinc-coating conforming to ASTM A 116, Class 3. Provide type of reinforcement as follows with 4.8 mm single pair of side rods:
      - Ladder design with perpendicular 4.8 mm cross rods spaced not more than 400 mm on center.
      - Truss design with 4.8 mm continuous diagonal cross rods spaced not more than 400 mm on center.

2. Anchoring Devices for Masonry: Provide straps, bars, bolts and rods fabricated from not less than 3.76 mm sheet metal or 10 mm diameter rod, unless otherwise indicated.

3. Concrete Inserts for Masonry:
   a. Unit Type: Furnish cast iron or malleable iron inserts of the type and size shown, hot-dip galvanized after fabrication with 44 grams zinc coating, ASTM A 153, Class B 2.
   b. Dovetail Slots: Where shown, furnish dovetail slots with filler strips, hot-dip galvanized as above.
   c. For installation of concrete inserts refer to the concrete Sections of these Specifications as well as the specific requirements of the concrete installer regarding placement of inserts which are to be used by the masonry installer for anchoring of masonry work.

4. Pre-molded Control Joint Strips: Solid rubber strips with a durometer hardness of 60 to 80 as determined by ASTM D 2240, designed to fit standard sash block and maintain lateral stability in masonry wall, size and configuration as indicated.
PART 3 – EXECUTION

3.1 INSTALLATION

A. Installation: Conform to the requirements of UBC 85 or ACI 531-83.

B. Thickness: Build masonry construction to full thickness shown on Drawings. Build single-width walls to the actual thickness of the masonry units, using units of nominal thickness indicated.

C. Build chases and recesses as shown or required to accommodate items specified in this and other Sections of the Specifications. Provide not less than 200 mm of masonry between chase or recess and jamb of openings and between adjacent chases and recesses.

D. Cut masonry units with motor-driven saws to provide clean, sharp, un-chipped edges. Cut units as required to provide continuous pattern and to fit adjoining construction. Use full-size units without cutting where possible.

E. Units erected when the ambient air has a temperature of more than 42°C in the shade and a relative humidity of less than 5% shall be protected from direct exposure to wind or sun for 48 hours after construction. Absorption rates of masonry units shall be adjusted by previously wetting to ensure a good solid bond with the mortar.

F. Bond Pattern for Exposed Masonry: Lay exposed masonry in the bond pattern shown, or if not shown, lay in running bond with vertical joint in each course centered on units in courses above and below. Bond and interlock each course of each width at corners, unless otherwise shown.

G. Lay-up walls to comply with specified construction tolerances, with courses accurately spaced and coordinated with other construction.

H. Stopping and Resuming Work: In each course, rack back 1/2-unit length for one-half running bond or 1/3-unit length for one-third running bond; do not tooth. Clean exposed surfaces for set masonry, and remove loose masonry units and mortar prior to laying fresh masonry.

I. Built-In Work: As construction progresses, build-in items specified under this and other sections of the specifications. Fill in solidly with masonry around built-in items:
   1. Fill space between hollow metal frames and masonry solidly with mortar.
   2. Where built-in items are to be embedded in the cores of hollow masonry units, place a layer of metal lath in the joint below and rod mortar or grout into core.

J. Non-Bearing Interior Partitions Walls: Build full height of story to underside of structure above, unless otherwise shown.

K. Mortar Bedding and Jointing:
   1. Mortar Mixes: ASTM C 270, Proportion Specifications Type N.
   2. Mix mortar ingredients for minimum of 5 minutes in a mechanical batch mixer. Use water clear and free of deleterious materials which would impair the work. Do not use mortar which has begun to set, or if more than 1 hour has elapsed since initial mixing. Re-temper mortar during 1 hour period as required to restore workability.
   3. Lay solid masonry units with completely filled bed and head joint; butter ends with sufficient mortar to fill head joints and shove into place.
   4. Lay hollow concrete masonry units with full mortar coverage on horizontal and vertical face shells; also bed webs on mortar in starting course on footings and foundation walls and in all
courses of piers, columns and pilasters, and where adjacent to cells or cavities to be reinforced or to be filled with concrete or grout.

5. Joints: Maintain joint width as shown, except for minor variations required to maintain bond alignment. If not shown, lay walls with 10 mm joints. Cut joints flush for masonry walls which are to be concealed or to be covered by other materials. Tool exposed joints slightly concave. Rake out mortar in preparation for application of sealants where shown.

6. Remove masonry units disturbed after laying; clean and relay in fresh mortar. Do not pound corners at jambs to fit stretcher units which have been set in position. If adjustments are required, remove units, clean off mortar, and reset in fresh mortar.

L. Horizontal Joint Reinforcement:
1. Provide continuous horizontal joint reinforcement as shown and as specified. Fully embed longitudinal side rods in mortar for their entire length with a minimum cover of 15 mm on exterior side of wall and 12 mm at other locations. Lap reinforcement a minimum of 150 mm at ends of units. Do not bridge control and expansion joints with reinforcing except at wall openings. Provide continuity at corners as well as wall intersections by using prefabricated L-sections and T-sections. Cut and bend unit as directed by manufacturer for continuity at returns, and other special conditions.

2. For single-width walls, space continuous horizontal reinforcement at 400 mm on center, unless otherwise indicated on Drawings.

3. Reinforce masonry openings greater than 300 mm wide, with horizontal joints approximately 200 mm apart, above the lintel and below the sill of the opening. Extend reinforcement a minimum of 600 mm beyond jambs of the opening, bridging control joints where provided.

M. Control Joints:
1. Provide control joints in block partitions, finished or unfinished at not more than 5 m on centers unless indicate otherwise on Drawings.

2. Control joints shall be vertical unbonded joints, maximum 9.5 mm wide, extending full height of the masonry work. Bond shall be broken with building paper placed against one face of joint with no mortar placed in continuous height of void.

3. Control joint material shall be expandable closed cell neoprene conforming to ASTM D 1056, 38 mm deep and 25 percent thicker before compression than joint width.

4. Top dress control joints with a sealant conforming to the requirements of Section 07900 - SEALANTS. Color of sealant shall be as selected and approved by the Engineer.

N. Anchoring Masonry Work:
1. Provide anchoring devices of types shown and as specified. If not shown or specified, provide standard type.

2. Anchor masonry to structural members where masonry abuts or faces such members to comply with the following:
   a) Provide an open space not less than 12 mm in width between masonry and structural member, unless otherwise shown and keep space free of mortar or other rigid materials.
   b) Anchor masonry to structural members with metal ties embedded in masonry joints and attached to structure. Provide anchors with flexible tie sections, unless otherwise shown.
   c) Space anchors at no more than 600 mm on center vertically and 900 mm on center horizontally.

O. Lintels:
1. Provide masonry lintels where shown and wherever openings of more than 300 mm for brick size units and 600 mm for block size units are shown without structural steel or other
supporting lintels.
2. Provide precast or formed-in-place masonry lintels. Thoroughly cure precast lintels before handling and installation.
4. Unless otherwise shown, provide one reinforcing bar for each 100 mm of wall thickness and of a size number not less than three times the number of meter of opening width.
5. For hollow masonry unit walls, use specially formed U-shaped lintel units with reinforcing bars placed as shown and filled with Type M mortar or coarse grout.
6. Provide minimum bearing at each jamb of 200 mm or as indicated on the Drawings.

3.2 REPAIR, POINTING AND CLEANING
A. Remove and replace masonry units which are loose, chipped, cracked, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in fresh mortar or grout, pointed to eliminate evidence of replacement.
B. During tooling of joints, enlarge any voids or holes, except weep holes, and completely fill with mortar. Point-up joints at corners, openings and adjacent work to provide a neat, uniform appearance, properly prepared for application of caulking sealant compounds.
C. Clean exposed concrete masonry units by dry brushing at the end of each day and after final pointing to remove mortar spots and drippings.

3.3 CURING
A. When temperature exceeds 25°C and where construction of a masonry wall is complete, cure mortar by covering the wall unit with wet burlap, jute sack or similar material for a minimum of two days.
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PART 1 – GENERAL

1.1 DESCRIPTION
A. Related sections:
   1. Unit Masonry: Section 04200.

1.2 JOB CONDITIONS
A. Protect adjacent surfaces and materials below from damage due to cleaning operations.
B. Keep cleaner containers away from extreme heat. Do not place containers in any position where they are subject to puncture.
2.1 MATERIALS

A. Cleaning solution for general masonry:

1. **Type:**
   A concentrated blend of surface acting acids, cheating and wetting agents formulated as a high efficiency, general purpose cleaner for new masonry and concrete surfaces not subject to metallic oxidation; Clear, non-flammable liquid.
   a. Hydrochloric acid : 5 PPM (7 mg/cm).
   b. Boiling point : 100 degC.
   c. Vapor Pressure : 94 mm Hg.
   d. Vapor density : 1.27.
   e. Solubility in water : 100 Percent.
   g. Percent volatile by volume : 98.6 percent.
2. **Preparation:**
   Job mixed with water before application, according to manufacturer's directions.
3. **Use:**
   Tan, pink masonry, glazed brick, structural tile, exposed-aggregate-general masonry surfaces.

B. Cleaning solution for manganese or vanadium - stained masonry:

1. **Type:**
   Clear liquid cleaner, a blend of organic and inorganic acids with special inhibitors, formulated as a safe effective cleaner for new masonry surfaces that are subject to metallic oxide stains:
   a. Hydrochloric acid : 5 PPM (7 mg/cm).
   b. Boiling point : 110 deg C (230degF).
   c. Vapor Pressure : Approximately 94 mm Hg.
   d. Vapor density : 1.27.
   e. Solubility in water : 100 percent
   f. Specific Gravity : 1.11.
   g. Percent volatile by volume : 85 percent.
2. **Use:**
   Soft-burned white, gray or brown brick and all other brick subject to metallic staining; concrete unit masonry; integrally colored concrete and mortar.
PART 3 – EXECUTION

3.1 PREPARATION
   A. Carefully check masonry surfaces.
   B. If necessary point with mortar.
   C. Allow 4 days after pointing before start of cleaning.
   D. Remove excess mortar using wooded paddles and scrapers.

3.2 CLEANING
   A. Do not use wire brushes.
   B. If metal tools are used, use only tools free of rust.
   C. Thoroughly rinse and pre-soak walls.
   D. Flush all loose mortar and dirt from surface.
   E. Wet to prevent "run-off" streaking.
   F. Apply solution using fibered wall washing brush.
   G. Scrape off mortar and re-apply cleaning solution.
   H. After scrubbing, clean thoroughly with pressurized water.

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PART 1 – GENERAL

1.1 SECTION INCLUDES
A. Sheet membrane waterproofing for the following:
   1. Toilets, and other wet areas.

1.2 SUBMITTALS
A. Submit product data, samples, general recommendations from waterproofing materials manufacturer, for types of waterproofing required. Include data showing that materials comply with the specified requirements.

1.3 TRANSPORTATION, HANDLING AND STORAGE
A. Deliver materials in manufacturer's unopened, labeled packing and in compliance with the manufacturer's storage, handling, installation and protection requirements.

1.4 WARRANTY
A. Provide written warranty, agreeing to replace and repair defective materials and workmanship. Warranty includes responsibility for removal and replacement of other work which concern sheet waterproofing. Warranty period is 10 years after date of substantial completion.

1.5 QUALITY ASSURANCE
A. Manufacturer: Obtain primary waterproofing materials of each type required from a single manufacturer, to the greatest extent possible. Provide secondary materials only as recommended by manufacturer of primary materials.

1.6 JOB CONDITIONS
A. Substrate: Proceed with waterproofing after completing substrate construction, openings and penetrating works.
B. Weather: Proceed with waterproofing and associated works only when existing and forecast weather conditions permit work to be performed in accordance with manufacturer's recommendations and warranty requirements.
2.1 WATERPROOFING MATERIALS

A. Waterproofing membrane: High performance polymer modified bitumen sheet membrane, 3 and 4 mm thick, reinforced with 200 g/m2 non-woven polyester fabric. Membrane shall be fully bonded, torch applied to the primed surface comply with the following requirements:

1. Flexible membrane, not effect with room temperature and not adhere under folding.
2. Actual thickness 4mm or 3mm ± 5%.
3. Weight 4 kg/m2 for 4mm thick membrane and 3 kg/m2 for 3mm thick membrane.
4. Reinforcement 200gm/m2 non-oven polyester fiber.
5. Bitumen content 96.1%.
6. Softing point 147°C.
7. Tensile strength longitudinal 1100N/5cm.
8. Tensile strength transversal 700N/5cm.
9. Longitudinal and transversal elongation 50%.
10. Cold bend test no cracks at 0°C.

B. Waterproofing for planter boxes:
   1. Double membrane applied in 2 layers fully bonded, torch applied to the primed substrate; first layer shall be 4 mm thick and the second layer shall be 3mm thick.

C. Waterproofing for general wet areas (toilets and wet areas):
   1. Single membrane, 4mm thick, fully bonded, torch applied to the primed substrate

2.2 MISCELLANEOUS MATERIALS

A. Primers: Provide the type of primer as recommended by the waterproofing material manufacturer.

B. Protection Board: Provide 3 mm thick multi-layer pressure bonded board with asphaltic impregnation as a protection for the waterproofing where indicated on the Drawings.

C. Separation Layer: Non-woven polyester fabric, density 180 g/m² and to be laid above the membrane where shown on Drawings.

D. Vapor Barrier: Polyethylene sheeting conforming to ASTM E154, minimum 200 microns thick having a vapor permeance rating not exceeding 0.063 perms conforming to ASTM E 96, and shall be laid with 300 mm overlapping.
3.1 INSTALLATION

A. General: Waterproofing works shall be executed by a specialized Sub-Contractor recommended by the waterproofing and/or lining manufacturer and approved by the Engineer.

B. Comply with waterproofing and/or lining manufacturer's recommendations regarding installation details, surface preparation, torch applied process, priming of surfaces as well as the overlapping.

C. Substrate shall be smooth, hard dry and free from high spots and depressions. Substrate shall be swept clean and free from dust, loose cement scale, oil, grease, foreign substances and debris.

D. Starting at the low point of the slab, apply the waterproofing membrane fully bonded laid torch applied for horizontal areas with minimum 75 mm overlap. Lay non-woven polyester fabric separation layer over waterproofing membrane prior to application of other finishing.

E. On vertical areas, apply the waterproofing membrane fully bonded laid torch applied fixed to walls with minimum 75 mm overlap. Use waterproofing manufacturer's standard materials. Apply protection board prior to backfilling.

F. Test the work after completion by water flooding to a minimum height of 75 mm for a period of 48 hours.

G. For the application of waterproof lining, follow manufacturer’s written instructions.

H. Submit 10 years guarantee for the waterproofing works done and the associated works covering the failure of materials or workmanship. Guarantee shall be signed by waterproofing Sub-Contractor and shall indicate which (Contractor or Sub-Contractor) has assumed the responsibility for the removal and the replacement of the works concealing the waterproofing work in case of failure of material or workmanship.

End of Section 07105
SPECIFICATION SECTION 07210
BOARD INSULATION

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1.2  Related Sections
1.3  References
1.4  Related Documents
1.5  System Description
1.6  Submittals
1.7  Mockup
1.8  Environmental Requirements

PART 2  PRODUCTS
2.1  Insulation Materials

PART 3  EXECUTION
3.1  Examination
3.2  Installation
3.3  Protection of Finished Work
## PART 1 – GENERAL

### 1.1 SECTION INCLUDES

A. Rigid or semi-rigid insulation boards including but not limited to the following:

1. Board insulation and integral vapor barriers, metal stud framing systems and insulation.
2. Fiber glass acoustic insulation to stud wall partitions.
3. Curtain wall insulation.

### 1.2 RELATED SECTIONS

A. Section 0420  Unit Masonry
B. Section 07531 Waterproofing Roof Membrane System.
C. Section 09250 Gypsum Board.

### 1.3 REFERENCES

A. ASTM C 208  Specification for Insulating Board (Cellulosic Fiber), Structural and Decorative.
D. ASTM C 552  Specification for Cellular Glass Block and Pipe Thermal Insulation.
F. ASTM C 578  Preformed, Cellular Polystyrene Thermal Insulation.
H. ASTM C 728  Specification for Perlite Thermal Insulation Board.
J. ASTM D 2842  Water Absorption of Rigid Cellular Plastics.
M. NFPA 255  Test of Surface Burning Characteristics of Building Materials.

### 1.4 RELATED DOCUMENTS

Drawings and general provisions of Contract.

### 1.5 SYSTEM DESCRIPTION

A. Materials of this Section: Provide continuity of thermal barrier at building enclosure elements.
1.6 SUBMITTALS
   A. Product Data: Provide latest manufacturer's data on product characteristics, performance criteria and limitations including.
   B. Manufacturer's Installation instructions: Indicate special environmental conditions required for installation and installation techniques.
   C. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.

1.7 MOCKUP
   A. Provide mockup of materials of this section in conjunction with Section 04200.
   B. Mockup may remain as part of the Work.

1.8 ENVIRONMENTAL REQUIREMENTS
   A. Do not install insulation adhesives when temperature or weather conditions are detrimental to successful installation.
PART 2 – PRODUCTS

2.1 INSULATION MATERIALS

O. Rigid Glass Fiber Board Insulation:
   1. Rigid Glass Board Insulation with Vapor Barrier: Glass fiber thermostetting resins complying with ASTM C 612, Class 1 and 2; density not less than 48 kg/cu m; minimum R-value of 4.3 at 24 °C; vapor barrier facing laminate of aluminum foil, Kraft paper, and glass scrim reinforcement, with perm rating of 0.02; manufacturer's standard sizes; thickness shown.
   2. Rigid Glass Fiber Board insulation - Unfaced: Glass fibers and thermo-setting resins complying with ASTM C 612, Class 1 and 2; density not less than 48 kg/cu m; minimum R-Value of 4.3 at 24 °C.; non-combustible per ASTM E 136.

P. Extruded Polystyrene Insulation: ASTM C 578 Type VII Cellular type, conforming to the following:
   1. Board Density: 35 kg/cu m.
   2. Board Size: 1200 x 2400 mm.
   3. Board Thickness: As indicated on drawings.
   4. Thermal Resistance: RSI of 0.87.
   5. Water Absorption: In accordance with ASTM D 2842 0.3% by volume maximum.
   8. Flame/Smoke Properties: In accordance with ASTM E 84.

Q. 50mm Rockwool or Fiberglass Board Acoustic Insulation Internally to Mechanical Rooms Walls:
   1. Internal: 50 mm thick rockwool or glass blankets/boards panels or greater to achieve the required noise levels in adjacent areas.
   2. Minimum absorption coefficient as Table Para 2.02 D.
   3. Insulation to be medium or high density (60 or 100 kg/m3) as recommended by the Acoustic Specialist.
   4. Individual panels/mats of insulation are to be fixed in individual metal frames panels manufactured from 0.6 mm galvanized sheet metal with 2 mm expand galvanized steel mesh to retain the insulation. Each panel is to be manufactured to abut adjacent panels and be securely fixed to the plantroom walls. At door openings, shafts, carriers, columns, floors and ceilings, custom panels are to be provided and coordinated to suit door frame details etc.
   5. For electrical goods and accessories, cutouts are to be provided with sufficient clearance to accommodate the electrical goods and accessories. The internal edges of the cut-outs are to have galvanizing sheet steel frames that are purpose made with no projecting corners that could cause physical damage.
   6. The thickness of the acoustic wall lining is to be adjusted to suit the 1/3 rd band octave sound spectrum of the plant selected and approved for insulation.
   7. External: Acoustic insulation to walls to be as for internal walls with the additional waterproof lining minimum thickness 0.5 mm such as “Melinex” (equal or approved) to avoid damage to the infill from rain, dust etc.
50mm Rockwool on glass blankets/boards/panels density 100 kg/m² (NRC 1.05)

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<th>125</th>
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50mm Rockwool on glass blankets/boards/panels density 60 kg/m² (NRC 0.9)

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R. Fiberglass Acoustic Insulation: In flexible rolls and semi rigid slabs free from shot and course fibers faced with non woven dimensionally stable black glass tissue. The acoustic insulation shall be 25 mm and 50 mm thick, 60 kg/m³ density and sound absorption coefficient (SAC) follows:

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S. The insulation shall be odorless, non-hygroscopic, non-toxic, rot proof and not sustain fungus or vermin. Moisture absorption shall not exceed 1% by weight when tested in accordance with ASTM C 553.

T. Curtain Wall Insulation (INSUL-26): Rigid mineral fiber insulation with integral foil-faced vapor barrier specially designed for use with curtain wall applications to comply with Section 08920.
1. Density: 96 kg/m³.
2. Thickness: As indicated on drawings.

U. Dark Curtain Wall Insulation: Semi-rigid mineral fiber insulation with a dark face color for use behind dark colored or black spandrel panels to comply with Section 09820.
1. Density: 96 kg/m³.
2. Thickness: As indicated on drawings.
3.1 EXAMINATION
A. Comply with Section 01410.
B. Verify that substrate, adjacent materials, and insulation boards are dry and ready to receive insulation.

3.2 INSTALLATION
A. Secure fasteners to substrate at a frequency recommended by manufacturer.
B. All fixings, adhesives, laps, joints, flashings etc. to be carried out in conformance with the manufacturers recommendations and instructions.
C. Scribe and cut all insulation tight to all protrusions.

3.3 PROTECTION OF FINISHED WORK
A. Comply with Section 01700.
B. Do not permit work to be damaged prior to covering insulation.

End of Section 07210
### SPECIFICATION SECTION 07840

**FIRE STOPPING**

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<td>General</td>
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</table>
PART 1 – GENERAL

1.1 SECTION INCLUDES

A. System Performance Requirements: Provide fire stopping systems that are produced and installed to resist the spread of fire, according to requirements indicated, and the passage of smoke and other gases.

1. Provide through-penetration fire stop systems with F ratings indicated, as determined per ASTM E 814, but not less than the fire-resistance rating of the constructions penetrated.
2. Provide through-penetration fire stop systems with T ratings as well as F ratings, as determined per ASTM E 814, where indicated.
3. Provide joint sealants with fire-resistance ratings indicated, as determined per ASTM E 119, but not less than that equalling or exceeding the fire-resistance rating of the construction in which the joint occurs.
4. For fire stopping exposed to view, traffic, moisture, and physical damage, provide products that do not deteriorate when exposed to these conditions.
5. For fire stopping exposed to view, provide products with flame-spread values of less than 25 and smoke-developed values of less than 450, as determined per ASTM E 84.

B. Submittals: In addition to product data for each type of product specified, submit the following:

1. Certification by fire stopping manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOCs) and are nontoxic to building occupants.
2. Shop drawings detailing materials, installation methods, and relationships to adjoining construction for each through-penetration fire stop system, and each kind of construction condition penetrated and kind of penetrating item along with design designation of qualified testing and inspecting agency.
3. Product certificates signed by manufacturers of fire stopping products certifying compliance of their products with specified requirements.
4. Product test reports from a qualified testing and inspecting agency evidencing compliance of fire stopping with requirements based on comprehensive testing of current products.

C. Fire-Test-Response Characteristics: Provide fire stopping that complies with the following requirements and those specified under the "System Performance Requirements" paragraph:

1. Fire stopping tests are performed by a qualified testing and inspecting agency, including UL, Warnock Hersey, or another agency performing testing and follow-up inspection services, that is acceptable to authorities having jurisdiction.
2. Through-penetration fire stop systems are identical to those tested per ASTM E 814 under conditions where positive furnace pressure differential of at least 0.01 inch of water is maintained at a distance of 0.78 inch below the fill materials surrounding the penetrating items in the test assembly.
3. Fire-resistive joint sealant systems are identical to those tested for fire-response characteristics per ASTM E 119 under conditions where the positive furnace pressure differential is at least 0.01 inch of water, as measured 0.78 inch from the face exposed to furnace fire.
4. Ratings of Fire stopping: As indicated by reference to designations of UL in their "Fire Resistance Directory" or by another qualified testing and inspecting agency.
PART 2 – PRODUCTS

2.1 GENERAL

A. Through-Penetration Fire stop Systems: Comply with the following requirements in providing system components that are compatible with each other, the substrates forming openings, and the items, if any, penetrating fire stops under conditions of service and application, based on testing and field experience.

1. Accessories: Provide the following components for each fire stopping system as needed to install fill materials and to comply with "System Performance Requirements" paragraph:

   a. Permanent forming/damming/backing materials including the following:
      (1) Semi refractory fiber (mineral wool) insulation.
      Ceramic fiber.
      (2) Sealants used in combination with other forming/damming materials to prevent leakage of fill materials in liquid state.
      (3) Fire-rated form board.
      (4) Joint fillers for joint sealants.
   b. Temporary forming materials.
   c. Substrate primers.
   d. Collars.
   e. Steel sleeves.

2. Fill Materials: Provide through-penetration fire stop systems composed of the fill materials indicated below:

   a. Ceramic-Fiber and Mastic Coating: Ceramic fibers in bulk form formulated for use with mastic coating, and ceramic fiber manufacturer's mastic coating.
      Ceramic-Fiber Sealant: Single-component formulation of ceramic fibers and inorganic binders.
      Intumescent, Latex Sealant: Single-component, intumescent, latex formulation.
   b. Intumescent Putty: Non-hardening, dielectric, water-resistant putty containing no solvents, inorganic fibers, or silicone compounds.
   d. Job-Mixed Vinyl Compound: Pre-packaged vinyl-based powder product for mixing with water at Project site to produce a paintable compound, passing ASTM E 136, with flame-spread and smoke-developed ratings of zero per ASTM E 84.
      Mortar: Pre-packaged dry mix composed of a blend of inorganic binders, fillers, and lightweight aggregate formulated for mixing with water at Project site to form a non-shrinking, homogenous mortar.
   e. Pillows/Bags: Re-usable, heat-expanding pillows/bags composed of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents and fire-retardant additives.
   f. Silicone Foam: Two-component, silicone-based liquid elastomer that, when mixed, expands and cures in place to produce a flexible, nonshrinking foam.
   g. Silicone Sealant: Moisture-curing, single-component, silicone-based, neutral-curing elastomeric sealant.

B. Fire-Resistive Elastomeric Joint Sealants: Chemically curing, elastomeric sealants of base polymer indicated complying with ASTM C 920 requirements and requirements specified in this Section applicable to fire-resistive joint sealants.

1. Sealant Colors: Provide selections made by Architect from manufacturer’s full range of standard colors for products of type indicated.

2. Single-Component, Neutral-Curing Silicone Sealant: Type S; Grade NS; Class 25; exposure-related Use NT, and joint-substrate-related Uses M, G, A, and (as applicable to joint substrates indicated) O.

i. Additional capability, when tested per ASTM C 719, to withstand the following percentage changes in joint width as measured at time of installation and still comply with other requirements of ASTM C 920:

1) 50 percent movement in both extension and compression for a total of 100 percent movement.
PART 3 – EXECUTION

3.1 GENERAL

A. Install through-penetration fire stops to comply with the "System Performance Requirements" paragraph and the through-penetration fire stop manufacturer's installation instructions and drawings pertaining to products and applications indicated.

B. Install fire-resistive joint sealant to comply with the "System Performance Requirements" paragraph, with ASTM C 1193, and with the sealant manufacturer's installation instructions and drawings pertaining to products and applications indicated.

End of Section 07840
# SPECIFICATION SECTION 07900

**SEALANTS**

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1.4  Quality Assurance
1.5  Job Conditions

### PART 2  PRODUCTS

2.1  Materials
2.2  Miscellaneous Materials

### PART 3  EXECUTION

3.1  General
3.2  Joint Preparation
3.3  Installation
3.4  Sealant Schedule
3.5  Cleaning And Protection
PART 1 – GENERAL

1.1 SECTION INCLUDES
A. Sealants required to make the entire buildings weather and water tight as shown on drawings and as specified in this section.

1.2 SUBMITTALS
A. Product Data: Submit manufacturers technical data for each joint sealer required, including instruction for joint preparation and joint sealer application.
B. Samples for Initial Selection Purposes: Submit the manufacturer's standard bead samples consisting of strips of actual products showing full range of colors available for each product exposed to view.
C. Samples for Verification Purposes: Submit samples of each type and color of joint sealer required. Install joint sealer samples in 12 mm wide joints formed between two 150 mm long strips of materials matching the appearance of exposed surfaces adjacent to joint sealers in the work.
D. Certificates: Submit certificates from manufacturers of joint sealers attesting that products comply with specification requirements and are suitable for the use indicated.

1.3 TRANSPORTATION, HANDLING AND STORAGE
A. Deliver materials to Project site in original unopened containers or bundles with labels showing manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multi-component materials.
B. Store and handle materials in compliance with manufacturers' recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.4 QUALITY ASSURANCE
A. Mock-Ups: Prepare a mock-up of each different type of sealant installation shown. For each different condition shown, display in mock-up materials on each side of joint and sealant type installed. Approved mock-ups shall establish installation standards required for actual corresponding sealant work.

1.5 JOB CONDITIONS
A. Do not proceed with installation of joint sealants unless requirements and manufacturer's instructions are satisfactory and applicable. Do not proceed with the installation of sealants under extreme temperature conditions which would cause joint openings to be at either maximum or minimum width or when such extreme temperatures or heavy wind loads are forecast during the period required for initial or nominal cure.
PART 2 – PRODUCTS

2.1 MATERIALS

A. General
   1. Provide joint sealers, joint fillers and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by the sealant manufacturer based on testing and field experience.
   2. Provide colors as indicated or, if not otherwise indicated, as selected by the Engineer from the manufacturer's standard colors to comply with color board.
   3. Where exposed to foot traffic, select marketed materials of sufficient strength and hardness to withstand traffic without damage or deterioration of sealant system.

B. Types of Sealants
   1. Sealant No.1 - Multi-Component Polyurethane Sealant: Polyurethane-based, 2-part elastomeric sealant (non-sag), conforming to ASTM C 920, Type M, Grade NS, Class 25 or FS-TT-S-0227E, Type II, Class A.
   2. Sealant No.2 - One-Component Polyurethane Sealant: Polyurethane-based, one part elastomeric sealant (non-sag), conforming to ASTM C 920, Type M, Grade NS, Class 25.
   3. Sealant No.3 - One-Component Acrylic Sealant: Acrylic ter-polymer, solvent-based, one-part, thermo-plastic sealant complying ASTM C 834; solids not less than 95 percent acrylic as recommended by the manufacturer for general use as an exposed building construction sealant.
   4. Sealant No.4 - Two-Component Polyurethane Sealant: Pourable polyurethane-based, 2-part elastomeric sealant (self-leveling), conforming to ASTM C 920, Type M, Grade P, Class 25, or FS-TT-S-0220, or FS TT-S-0227.
   5. Sealant No.5 - Mildew-Resistant Silicone Rubber Sealant: Silicone rubber-based, one part elastomeric sealant, conforming to ASTM C 920, Type S, Grade NS, Class 25 or FS TT-S-1543, Class A; specifically for mildew resistance and recommended by the manufacturer for interior joints in wet areas, passing ANSI A 136.1 test for mold growth.
   6. Sealant No.6 - One-component construction silicone sealant: Conforming to ASTM C 834 and ASTM C 920 with movement capability plus or minus 25 percent, excellent adhesion to glass and aluminium.

C. Joint Filler
   1. Compressible Joint Filler: Manufacturer's standard open cell flexible foam strip of polyurethane or other weather-resistant foam, saturated with butylene or other non-drying liquid sealant/adhesion.
   2. Compressible Joint Filler for Paving: Provide joint fillers of thickness and widths as shown on the Drawings. Joint fillers shall be preformed strips of asphalt saturated fiber board conforming to the requirements of ASTM D 1751.

2.2 MISCELLANEOUS MATERIALS

A. Joint Primer/Sealer: Provide type of joint primer/sealer recommended by sealant manufacturer for joint surfaces to be primed or sealed.

B. Bond Breaker Tape: Polyethylene tape or other plastic tape as recommended by sealant manufacturer to be applied to sealant contact surfaces where bond to substrate or joint filler must be avoided for proper performance of sealant.
C. Sealant Backer Rod: Preformed, compressible rod stock of closed-cell polyethylene foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable non-absorptive material as recommended by sealant manufacturer for compatibility with sealant.
PART 3 – EXECUTION

3.1 GENERAL
A. Conform to sealant the manufacturer's printed installation instructions except where more stringent requirements are shown or specified, and except where manufacturer's authorized technical representative directs otherwise.

3.2 JOINT PREPARATION
A. Clean out joints immediately before installing joint sealers to conform to the recommendations of joint sealer manufacturer as well as the following requirements:
B. Remove foreign material from joint substrates which could interfere with adhesion of joint sealer, including dust; paints, except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer; old joint sealers; oil; grease; waterproofing; water repellent; water; and surface dirt.
C. Clean concrete, masonry, unglazed surfaces of ceramic tile and similar porous joint substrate surfaces, by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealers.
D. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air. Remove laitance and form release agents from concrete.
E. Clean metal, glass, porcelain enamel, glazed surfaces of ceramic tile; and other nonporous surfaces by chemical cleaners or other means which are not harmful to substrates or leave residues capable of interfering with adhesion of joint sealers.
F. Joint Priming: Prime joint substrates where indicated or where recommended by joint sealer manufacturer based on preconstruction joint sealer-substrate tests. Apply primer to comply with joint sealer manufacturer's recommendations. Confine primers to areas of joint sealer bond, do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION
A. Set joint filler units with no voids or gaps between ends at proper depth of position in joint to coordinate with other work, including installation of bond breakers, backer rods, and sealants. Voids and gaps between joint fillers ends must be avoided.
B. Install sealant backer rod for sealants, except where shown to be omitted or recommended to be omitted by the sealant manufacturer for the application indicated and as approved by the Engineer.
C. Install bond breaker tape between sealants and joint fillers where indicated and where required by manufacturer's recommendations to ensure that elastomeric sealants will perform properly.
D. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.
E. Seal joints before adjacent surfaces are waterproofed or painted.
F. Install sealant to depths as shown or, if not shown, as recommended by sealant manufacturer.
G. Spillage: Do not allow sealants or compounds to overflow or spill onto adjoining surfaces, or to migrate into voids of adjoining surfaces. Clean joint surfaces by whatever means may be necessary to eliminate evidence of spillage.

H. Recess exposed edges of exposed joint fillers slightly behind adjoining surfaces, unless otherwise shown, so that compressed units will not protrude from joints.

I. Bond ends of joint filler together with adhesive or weld by other means as recommended by the sealant manufacturer to ensure continuous watertight and airtight performance.

3.4 SEALANT SCHEDULE

A. Contractor as per the Engineer approval shall provide one of the sealant types listed below for the corresponding joint type:

1. Exterior Joints
   j. Joints between metal frame and concrete or masonry and joints between marble cladding:
      - Sealant No.1
      - Sealant No.2
   k. Expansion and control joints:
      - Sealant No.1
      - Sealant No.2
   l. Exterior sills, jambs, and heads of window frames, door frames, louvers and similar openings and where metal, wood or other materials abut or join masonry concrete or each other:
      - Sealant No.2
      - Sealant No.3
   m. Horizontal joints in pavement and sidewalks:
      - Sealant No.4

2. Interior Joints
   n. Interior sill, jamb, around window and door frames and all items adjoined to masonry or concrete surfaces.
      - Sealant No.2
      - Sealant No.3
   o. Expansion and control joints:
      - Sealant No.1
      - Sealant No.2
   p. Joints between plumbing fixtures and other elements of wet areas:
      - Sealant No.5

3. Exterior and Interior Glazing:
   - Sealant No.6

3.5 CLEANING AND PROTECTION

A. Clean off sealants or sealant smears adjacent to joints as work progresses by methods and with cleaning materials approved by sealant manufacturers.

B. Protect joint sealers during and after curing period from contact with contamination.
substances or damage resulting from construction operations or other causes so that they are without deterioration or damage at the time of Substantial Completion.

End of Section 07900
## African Development Bank - Sudan
### Relocation and Outfitting Project
#### Volume III – Civil Works Specifications

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### Specification Section 08211

**Wood Doors and Frames**

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PART 1 – GENERAL

1.1 SECTION INCLUDES
A. Wood doors and frames as shown on the Drawings and as specified in this section.

1.2 SUBMITTALS
A. Product Data: Submit door manufacturer's product data for each type of wood door, including details of core and edge construction, unless otherwise indicated.
B. Samples: Submit samples of door faces representing typical range of color and grain, strips of solid wood of species to be used for exposed edges, trim and other solid wood components.

1.3 TRANSPORTATION, HANDLING AND STORAGE
A. Protect wood doors during transit, storage and handling to prevent damage, soiling and deterioration. Comply with requirements of referenced ANSI standards and recommendations of door manufacturer.
B. Identify each door with individual opening numbers which correlate with designation system used on shop drawings for doors, frames and hardware, using temporary, removable or concealed markings.

1.4 WARRANTY
A. Door Manufacturer's Warranty: Submit two copies of written warranty in door manufacturer's standard form signed by the Manufacturer, Installer and Contractor, agreeing to repair or replace defective doors which have warped (bow, cup or twist) or which shows photographing of core construction below in face veneers, or do not conform to tolerance limitations of NWMA and AWI.
B. The warranty shall also include refinishing and reinstallation which may be required due to repair or replacement of defective doors where defect was not apparent prior to hanging.
C. Warranty shall be valid for a period of 5 years from the time of substantial completion.
PART 2 – PRODUCTS

2.1 WOOD DOORS - GENERAL
A. Doors shall be fabricated meeting the applicable requirements of the quality standard of the Architectural Woodwork Institute.
B. Door Size: Width, height and design shall be as shown on Drawings. Door shall be 44 mm thick, unless otherwise required by manufacturer or indicated on Drawings.
C. Tolerances: Size, squareness and warp tolerances shall be in accordance with NWMA 1.S.1.
D. Prefit and premachine wood doors at factory complying with tolerance requirements of AWI for prefitting. Machine doors for hardware requiring cutting of doors. Comply with final hardware schedule and door frame shop drawings and with hardware templates and other essential information required to ensure proper fit of doors and hardware.
E. Wood used for doors and frames shall be approved by the Engineer as well as the door construction and design.

2.2 SOLID WOOD PANEL DOORS
A. Doors shall be constructed of best quality hardwood with a minimum thickness of 44 mm, unless otherwise required by door manufacturer or indicated on Drawings.
1. Type of wood shall be teak for external doors and oak for internal doors or as indicated on Drawings.
2. Stiles, top and bottom rails, decorative panels and moldings, transoms, sidelights, shall be of sizes and patterns as shown on Drawings and as approved by the Engineer.
B. Door components shall be assembled using tongued and grooved connections as well as adhesive Type I and in accordance with the fabrication procedures mentioned below.
1. Where indicated on Drawings, Submit various decorative designs for panels for the Engineer selection and approval.

2.3 SOLID CORE FLUSH WOOD DOORS
A. Shall be constructed of solid wood inside stiles and rails with blocking or mineral fill, bonded together using type I adhesive. Door shall have a face veneer, 0.6 mm thick premium grade oak wood specie. Lumber for stiles and rails shall be AEI premium grade.

2.4 HOLLOW CORE FLUSH DOORS
A. Doors shall be constructed of at least 50% solid wood blocks bonded together with water resistant adhesive notched into stiles and a metal or timber frame. Lumber for stiles and rails shall be softwood AWI premium grade. Moisture content of wood shall be satisfactory for intended use. Provide 3-ply oak wood face veneers, 0.6 mm thick, premium grade. Doors shall be sound, rigid and free from defects and warp. All edges shall be aligned and smooth.

2.5 FLUSH DOORS: FOR PAINT GRADE; 3/4 HR FIRE RATED
A. Core Construction: 38mm thick high density wood particle board, minimum density 450 kg/m$^3$. 
B. Sub face: Minimum 3.2mm thick Type S25 Hardboard on both sides.
C. Face Veneer: 0.6mm Oak veneer glued to hardboard surfaces and lipped over edge lipping.
D. Edge lipping: Minimum 8 mm thick hardwood radio frequency applied around four edges.
E. All paint grade doors shall be filled, sanded smooth, primed at works and finished on site; 3 coat oil based paint system.
F. Door Thickness -45mm minimum.
G. Class to BS 1186, Part 1, Class CHS or equal approved.

2.6 FLUSH DOORS: H.W. VENEER WITH TRANSPARENT FINISH: NON AND 3/4 HR FIRE RATED
A. Core: 38mm thick high density wood particle-board, minimum 450/m3 density.
B. Sub facing: Minimum 3.2 mm thick, marine plywood on both sides.
C. Face veneer: 0.6 mm premium quality American White Oak veneer.
D. Edge lipping: Minimum 8 mm thick Oak hardwood radio frequency applied around four edges.
E. All veneer doors requiring transparent finish shall be factory finished, i.e. wax polished.
F. Door thickness 45mm minimum.
G. Class to BS 1186, Part 1, Class CHS or equal approved.

2.7 FLUSH DOORS: FOR PAINT GRADE – 1&1/2 HOUR FIRE RATED
A. Sub-facing: Minimum 10mm thick fire resisting (antiflame) high density particle board on both sides.
B. Face Veneer: 0.6mm premium quality oak veneer lipped over edge lipping.
C. Core Construction: Minimum 28mm wide x 24mm thick (unless otherwise recommended by the door manufacturer for fire certification) softwood butt jointed and glued edge to edge to form a solid laminated construction.
D. Edge Lipping: Minimum 8mm thick hardwood radio frequency glued all around.
E. Finish: All paint grade doors to be primed, filled and sanded in factory and painted on site; 3 coat oil based paint system.

2.8 DOOR FRAMES
A. Door Frame Type: As indicated on Drawings and in accordance with the following requirements:
   1. Solid Wood Frames:
      a. Type of Wood: Use rigid, square and uniform, best quality solid hardwood, architectural grade, clear all heart. Type of wood shall be as indicated on Drawings.
      b. Wood used shall be of a species listed as suitable for doors frames and shall match with type specified for the related wood door.
      c. Frame Sizes, Rebates and Shapes: As shown on Drawings and as approved by the Engineer. Frame rebates shall be 13 mm minimum depth for the internal doors and 19 mm for the external doors. Frames shall have wood architraves as shown on Drawings.
2.9 **FABRICATION**

A. Openings: Where indicated, cut and trim openings through doors and panels complying with the applicable requirements of referenced standards for the kind of doors required.

B. Exterior Doors: Treat exterior doors at factory with water repellent after manufacturing has been completed.

C. Assembly: Assemble solid panelled doors and frames using be tongued and grooved connections with Type I waterproof adhesive.

D. Adhesives: Assemble doors using Type I waterproof adhesives.

E. Factory-Finishing: Provide manufacturer's standard finish to match approved sample.

2.10 **FINISH**

A. Doors and Frames Finish: As indicated on Drawings and in accordance with the requirements of Section 09900 - PAINTING.
PART 3 – EXECUTION

3.1 INSTALLATION

A. Each door unit shall be installed in accordance with the manufacturer's instructions including handling and storage recommendations.

B. Doors shall be fitted to the following tolerances:
   1. 3.18 mm on each vertical side and top.
   2. 13 mm on bottom, except when fitted hardware requires otherwise.
   3. Bevel non-rated doors 3.18 mm in 50 mm at lock and hinge edges.

C. Install finish hardware to the templates provided. Fit to frames and machine for hardware to whatever extent not previously worked at factory as required for fit and uniform clearance at each edge.

D. Restore finish on edges of shop-finished doors before installation, if fitting or machining is required at the job site.

3.2 ADJUST AND CLEAN

A. Operation: Rehang or replace doors which do not swing or operate freely, as directed by the Engineer.

B. Finished Doors: Refinish or replace doors damaged during installation as directed by the Engineer.

C. Institute protective measures as recommended and accepted by door manufacturer to assure that wood doors will be without damage or deterioration at time of substantial completion.

End of Section 08211
SPECIFICATION SECTION 08310
ACCESS DOORS AND PANELS

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PART 1 – GENERAL

1.1 SECTION INCLUDES
A. Metal access door, panel and frame units for walls, ceilings and floors, insulated with or without fire resistance ratings for accessing mechanical, electrical or other concealed items requiring maintenance admission including but not limited to the following:
B. Interior and exterior metal access doors, panels and frames for fire rated and unrated access door openings.
C. Factory prime painting of work of this section.
D. Accessory hardware, mounting brackets, clips and fasteners.

1.2 RELATED SECTIONS
A. Section 04200 Unit Masonry
B. Section 09250 Gypsum Board
C. Section 09900 Painting

1.3 REFERENCES
A. ASTM A 167: Specification for Stainless and Heat-Resisting Chromium Nickel Steel Plate, Sheet and Strip
B. ASTM A 366: Specification for Steel Sheet, Carbon, Cold Rolled, Commercial Quality
C. ASTM A 568: Specification for Steel, Sheet, Carbon and High Strength, Low alloy, Hot Rolled and Cold Rolled
D. ASTM A 569: Specification for Steel, Carbon (0.15 Maximum Percent) Hot-Rolled Sheet and Strip, Commercial Quality
E. AWI: Standard Welding Code

1.4 QUALITY ASSURANCE
A. Manufacture labeled doors and frames in strict accordance with specifications and procedures of UL requirements.
B. Welding of steel shall conform to the requirements of AWS Structural Welding Code.

1.5 SUBMITTALS
A. Submit schedule of Access Doors and Frames.
B. Product Data: Submit copies of manufacturer’s latest published literature for materials specified herein shall be submitted for approval, and approval obtained before materials are delivered to the site.
C. Certificates: Submit certificates attesting to compliance with these specifications shall be submitted to the Engineer for approval. Obtain approval prior to the fabrication and delivery of the material.
D. Shop Drawings: Submittal shall be a complete and comprehensive set of coordinated plans of the project showing access door and panel locations, including items to be accessed, nature of adjacent construction, size, fire rating requirements, location with respect to floor
and contract responsibility. Shop drawings will show panel or door construction with trims, finishes, locks and opening mechanisms and surrounding construction.

E. Provide samples of doors and panels including locking mechanisms as directed by the Engineer.

1.6 DELIVERY, STORAGE AND HANDLING

A. Avoid damage to finished surfaces while working and protect the work from damage after it is in place.

B. Deliver materials to the job site ready for use and fabricated in as large sections and/or assemblies as practical. Assemblies shall be identical to approved shop drawings, samples and certificates.

C. Store materials under cover in a dry and clean location, off the ground. Do not damage or mark prime coats and/or galvanizing. Remove materials which are damaged or otherwise not suitable for installation from the job site and replace with acceptable materials at no additional cost to the Owner.
PART 2 – PRODUCTS

1.1 MANUFACTURERS

A. Provide products by manufacturers who have manufactured similar items for a period of 5 years.

1.2 PRODUCTS

A. Painted Steel Access Panel: Exposed steel door access panel with factory applied prime-paint finish, designed for installation in plastered walls or ceilings; 16 gauge perimeter frame with 22 gauge expanded galvanized metal casing bead attached; 14 gauge flush door panel; with concealed hinges that open to not less than 130 degrees.
   1. Size: 600 mm x 600 mm, unless otherwise indicated.
   2. Latch type: Key operated cylinder lock.

B. Painted Steel Access Panel: Exposed steel door access panel with factory applied prime paint finish, designed for installation in a gypsum board surface; 16 gauge frame; 14 gauge door panel; galvanized steel bead continuous all sides; with concealed hinges that open to not less than 130 degrees.
   1. Size: 600 mm x 600 mm, unless otherwise indicated.
   2. Latch type: Key operated cylinder lock.

C. Stainless Steel Access Panel: Exposed stainless steel door access panel designed for installation in exposed masonry, tile, plaster, or gypsum board surfaces; exposed 16 gauge perimeter frame; 16 gauge door panel with concealed hinges that open to not less than 130 degrees.
   1. Size: 600 mm x 600 mm, unless otherwise indicated.
   2. Latch type: Key operated cylinder lock.

D. Gypsum Board Faced Access Panel: Specially designed drywall ceiling panel constructed of primed steel frame to receive field applied gypsum board surface, 16 gauge, frame, 18 gauge door sub-panel, concealed pivot hinge designed to allow door to open in 2 stages.
   1. Size: As indicated.
   2. Latch: Flush screwdriver-operated type with plastic grommet.

E. Access Panel: Flush panel with drywall flange.
   1. Material: Steel with factory applied prime paint finish; 16 gauge frame; 14 gauge panel; galvanized steel bead continuous all sides, to be concealed.
      a. Optional frame material 0.060 extruded aluminum.
      b. Hinge: Concealed continuous hinge.
      c. Size: 460 mm x 460 mm, unless otherwise shown on the Drawings.
      d. Latch operator: Cylinder lock.

F. Cement plaster on metal lath:
   1. Materials:
      2. Steel plate 3 mm thick with steel frame and hinges.
      3. Metal lath covered with cement plaster.
         a. Adhesive mastic to receive covering material and finishing as specified.
4. Size: 600 x 600 mm unless otherwise indicated.

G. Fire Rated, Painted Steel Access Panel: Fire rated, steel, factory applied prime paint finish, designed for installation in masonry, gypsum board, or plaster surfaces; exposed 16 gauge perimeter frame; 20 gauge door panel, with 50 mm mineral fiber sandwiched insulation and concealed hinges and automatic panel closer. Steel is chemically bonded with prime coat of baked-on electrostatic powder steel.
   1. Size: 600 mm x 600 mm, unless otherwise indicated.
   2. Latch type: Self latching, key operated cylinder lock. Coordinate with Hardware Supplier.

H. Fire Rated Stainless Steel Access Panel: Fire rated, 1-1/2 hour; stainless steel; designed for installation in exposed masonry, tile, plaster, or gypsum board surfaces.
   1. Latch: Self latching; flush ring type unless cylinder lock is indicated.
   2. Anchors: Type and quantity as required for substrate and size of door.

I. Access Panel AP-36: Stainless steel, flush panel, exposed frame.
   1. Material: Stainless steel with number 4 satin finish; 16 gauge frame; 14 gauge panel.
   2. Hinge: Concealed hinge.
   3. Size: 600 mm x 600 mm unless otherwise indicated on the Drawings.
   4. Latch operator: Cylinder lock.

J. Floor Access Panel: Floor access hatch with recessed steel plate cover to accept carpet or resilient tile with steel enclosed insulation, torsion bar balanced, with snap-lock latch and removable handle.
   1. Cylinder lock to receive interchangeable core provided under Section 08710.
   2. Size: 760 mm x 900 mm.

K. Anchors: Provide type and quantity as recommended by access panel manufacturer for substrate construction type and size of panel.

L. Locks: Provide flush type key cylinder locks where specified. Key locks alike. Provide not less than 2 keys with 1 key for each panel up to not more than 10 keys.

1.3 MATERIALS

A. Sheet Steel shall be commercial quality, cold-rolled, pickled, annealed and stretcher-leveled, entirely free from scale, pitting, wave or other defects. Gauges specified herein for sheet steel refer to the U.S. Standard Gauge for Sheet Iron and Steel.

B. Hot rolled prime quality carbon sheet steel shall conform to ASTM A 569 and ASTM A 568.

C. Cold rolled stretcher level sheet steel shall conform to ASTM A 366 and ASTM A 568.

D. Stainless Steel: ASTM A 167, Type 302 or 304 stainless steel with a No. 4 finish.

E. Sound-Deadening and Heat Retarding Filler for fire rated steel panels and doors shall be mineral wool or other inorganic insulating non-combustible non-settling material and shall comply with label requirements.

F. Accessories: Provide manufacturer's standard units for supports, anchors, inserts and fasteners.

G. Paint: Shop paint shall be an approved manufacturer's baked-on, rust-inhibitive, filler and primer type.

H. Hardware consisting of hinges, pulls, locks, latches, etc. shall be manufacturer's standard for the product selected.
I. Hardware shall be concealed to the greatest extent possible and provided with tamperproof fittings.

J. Fire rated access panels shall be equipped with UL approved hardware.

K. Finishes shall match surrounds or shall be as shown on the Schedules and Drawings.

1.4 FABRICATION

A. Access doors and frames shall be of the manufacturer’s standard design and dimensions, and fabricated by skilled workmen in accordance with best shop practice. Work shall be strong and rigid, neat in appearance and free from defects.

B. Exposed surfaces shall be free from warp, wave and buckle with corners square unless otherwise indicated. Set members in proper alignment and relationship to adjoining work, with surfaces straight and in true plane. Mitered joints shall be well formed and in true alignment. Arisses shall be straight and true.

C. Fasteners shall be concealed where possible. Where indicated on the drawings, or required, exposed screws shall be flat head, countersunk, Phillips or Jackson head type.

D. Provide self-closing labeled doors and frames where access doors and frames occur in walls and partitions scheduled to be labeled or fire rated. Such doors and frames shall be constructed as tested and approved by Underwriters’ Laboratories. Labels shall be left in place on doors and frames.

E. Access Doors: In addition to access doors shown on drawings, provide access doors to service fire dampers, controls, access valves, cleanouts and other equipment requiring access in walls and furred spaces. Contractor shall coordinate the exact location and quantity with mechanical and electrical requirements. Access doors are not required at suspended acoustical ceilings unless specifically shown.
PART 3 – EXECUTION

1.1 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.

1.2 PREPARATION
A. Examine the 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. To avoid delays, coordinate and schedule work of this Section with the work of related trades, with particular attention given to the installation of items embedded in masonry.
C. Provide templates as required to related trade for location of support and anchorage items.
D. Dissimilar Materials: Isolate aluminum from masonry, concrete, wood and dissimilar metals by coating with heavy-bodied bituminous paint or by using a non-absorbent gasket. Select fasteners to prevent galvanic action.
E. Do not install access doors and frames until locations have been approved by the Engineer.

1.3 INSTALLATION
A. Access door and frame work shall be fabricated and installed in a thorough and workmanlike manner by skilled workmen to the complete satisfaction of the Engineer.
B. Install work of this section square, plumb, straight, true to line or radius, accurately fitted and located, with flush tight hairline joints.

1.4 FIELD QUALITY CONTROL
A. Access doors and frames which are defective, have inoperative hardware or which prevent proper installation of other trades, shall be removed and replaced at no additional cost.

End of Section 08310
SPECIFICATION SECTION 08710
FINISH HARDWARE

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PART 1 – GENERAL

A.1 SECTION INCLUDES

A. Coordination with the engineer to establish client’s requirements, functional security zoning, security levels and access requirement.

B. Verify the accuracy of quantities, sizes, finish and proper hardware to be provided. Determine all details related to door locksets functions.

C. Propose for engineers approval full scheme for access control and hardware sets.

D. Provision and installation of all doors hardware sets to satisfy the approved scheme.

A.2 APPLICABLE PUBLICATIONS

A. Applicable Publications :

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

B. American National Standards Institute, Inc. ANSI/ BHMA:

A117.0 Providing Accessibility and Usability for Physically Handicapped People
A156.1 Butts and Hinges.
A156.2 Locks and Lock Trim.
A156.3 Exit Devices.
A156.4 Door Controls - Closers.
A156.5 Auxiliary Locks and Associated Products.
A156.6 Architectural Door Trim.
A156.7 Template Hinge Dimensions.
A156.8 Door Controls - Overhead Holders.
A156.9 Cabinet Hardware.
A156.11 Cabinet Locks.
A156.12 Interconnected Locks and Latches.
A156.13 Mortise Locks and Latches.
A156.14 Sliding and Folding Door Hardware.
A156.15 Closer Holder Release Devices.
A156.16 Auxiliary Hardware.
A156.17 Self Closing Hinges and Pivots.
A156.18 Materials and Finishes
A156.21 Thresholds Gasketing Systems
A156.22 Door Gasketing System
A156.25 Electrified Locking Devices
A156.28 Master Keying Systems
A117.1 Providing Accessibility and Usability for Physically Handicapped People
BHMA Builders Hardware Manufacturers' Association: 
Materials and Finishes.
National Fire Protection Association: 
NFPA 80 Fire Door and Windows.
Underwriters Laboratories, Inc.: (UL)
Building Material Directory.
International Building Code (IBC)
American with Disabilities ACT (ADA)

A.3 SUBMITTALS
A. Security and access egress control scheme and related hardware sets.
B. Product Data: Submit manufacturer's technical product data for each item of hardware. Include whatever information may be necessary to show compliance with the requirements and include installation and maintenance of operating parts and finish instructions.
C. Hardware Schedule: Submit final hardware schedule including coordination with doors, frames and related work to ensure proper size, thickness, hand, functions and finish of hardware. Submit separate detailed schedule showing the implementation of the Owner's final instruction on the keying of locks.
D. Samples: Prior to submittal of hardware schedule and ordering of hardware, submit one sample of each type of exposed hardware unit, finished as required, and tagged with full description for the approval of the Engineer.

A.4 DELIVERY, STORAGE, AND HANDLING
A. Hardware shall be delivered to the project site in the manufacturer's original packages. Each article of hardware shall be individually packaged in the manufacturer's standard commercial carton or container, and shall be properly marked or labeled to be readily identifiable with the approved hardware schedule.
B. Each change key shall be tagged or otherwise identified with the door for which its cylinder is intended. Where double cylinder functions are used or where it is not obvious which is the key side of a door, appropriate instructions shall be included with the lock and on the hardware schedule. Manufacturer's printed installation instructions, fasteners, and special tools shall be included in each package.

A.5 SPECIAL TOOLS
A. Special tools, such as those supplied by the manufacturer, unique wrenches, and dogging keys, shall be provided as required to adjust hardware items.

A.6 WARRANTY
A. Submit written guarantee signed by Manufacturer and Contractor, agreeing to replace hardware items which fail in material or workmanship within 5 years of the date of substantial handing over.
A.7 QUALITY ASSURANCE

A. Manufacturers: Obtain each type of hardware from a single manufacturer to the greatest possible extent.

B. Supplier: A recognized architectural hardware supplier with warehousing facilities, and has been providing hardware for similar Projects for a period of not less than 2 years and who has, or will employ an experienced architectural hardware consultant to be available, at reasonable times during work, for consultation about Project's hardware requirements to the Engineer as well as Contractor.

A.8 EXTRA MATERIALS

A. Provide 10% of overall quantities of lock cylinders, handles and key blank as spare parts.
PART 2 – PRODUCTS

2.1 MATERIALS

A. Hardware, Finish - General:
1. Provide hardware for fire-rated openings in compliance with U/L and NFPA No.80. This requirement takes precedence over other requirements for such hardware. Provide only hardware which has been tested and listed by U/L for types and sizes of doors.
2. Furnish items of hardware for proper door swing.
3. Provide strikes with curved lips. Provide extended lips when necessary. Provide strike boxes.
4. Provide lock devices which allow rooms to be opened from inside without a key.
5. Finishes: should be comply to BHMA code and as follows
   a. Locks:
      626, Stain Chrome plated
   b. Door pulls, push bars, push plates:
      630 Stainless steel satin finish.
   c. Kick plates:
      630, stainless steel, satin finish.
   d. Exit devices:
      626, Stain chrome plated
   e. Butts:
      (1) Exterior doors and interior doors where brass or bronze is specified: 626.
      (2) Interior doors where steel is specified: 625.
      (3) Exterior all doors material stainless steel finish: 630.
   f. Door stops, holders, dead locks, mortise, bolts, pivots and miscellaneous hardware : 626 or 630.
   g. Exposed arms and covers of closers : 689.

B. Locks, Latches and Lever Trims
1. ANSI A156.13, Grade 1, mortise with 19 mm mechanical anti-friction latch bolt with 25 mm throw deadbolt, U/L labelled on all units.
2. To the maximum extent possible, locksets, latchsets and deadlocks shall be the products of a single manufacturer. Strikes for wood frames and pairs of wood doors shall be furnished with wrought boxes. Lock and latch set trim (knobs, lever handles, roses and escutcheons) shall be of a safety design in accordance with manufacturer's standard practice and be suitable for heavy duty usage. Provide handles, pulls, latches locks and other operating hardware that are easy to grasp with one hand and do not require twisting of the wrist, tight grasping or tight pinching to operate. Acceptable designs include, but are not limited to lever-operating hardware, push-type hardware, and U- shaft hardware.
3. Mortise Lock and Latchsets:
   Mortise lock, latchesets, and strikes shall conform to British Standards. Strikes for security doors shall be rectangular without curved lip. Mortise type locks and latches for doors 44 mm thick and over shall have adjustable bevel fronts or otherwise conform to the shape of the door. Mortise locks shall have armored fronts. Reversible latch bolt with double throw
dead bolt which operates by cylinder with harden steel pins minimum 19mm throw.

4. Auxiliary Locks and Associated Products:

Bored and mortise deadlocks and latchsets, narrow style locks, rim locks, and electric strikes shall conform to British Standard. Bolt and latch retraction shall be dead bolt style. Strike boxes shall be furnished with dead bolt and latch strikes.

5. Lock Cylinders (Mortise, Rim and Bored):

Lock cylinders shall have not less than five pins. Cylinders shall have key removable type cores. A grand master keying system shall be provided. Key to be dual profile and patented to accept a minimum of 100,000 variations. A construction master keying system shall be provided. Disassembly of knob or lockset shall not be required to remove core from lockset. All locksets, exit devices, and padlocks shall accept same europrofile cores.

6. Locksets for Lead-Shielded Doors:

Locksets for lead-shielded doors shall be provided with factory-installed lead linings. Lead linings shall not be less than the thickness of the lead in the door in which the lockset is required.

7. Lock Trim:

Lock trim shall be cast, forged, or heavy wrought construction of commercial plain design. In addition to meeting the test requirement, knobs, lever handles, roses, and escutcheons shall be 1.27 mm thick, if unreinforced. If reinforced, the outer shell shall be 0.89 mm thick and the combined thickness shall be 1.78 mm except that knob shanks shall be 1.52 mm thick.

8. Lever Trim:

Lever trim shall be solid core - stainless steel Grade 316 fixed with heavy duty cartridge Self progressing spring system which ensures independent spring of lever trim which always returns to horizontal without relying exclusively on the latch spring of lock.

C. Smoke Detectors and Magnetic Holders

1. Smoke detectors and magnetic holders shall conform to Section 16720 FIRE ALARM SYSTEM. Door closers with integral holders connected to a separate detection device, or closers with integral holders and detector units sensing particles of combustion, which when activated will release the holder mechanism causing the closer to close the door, may be used in lieu of separate closers, detectors and magnetic holders. Alternate closers shall provide the same function as closers specified and shall be listed or labeled by a nationally recognized independent testing laboratory.

D. Door Closers:

ANSI A156.4, Type C02011, C02021, or C02031 as required to fit conditions.

1. Surface type closers shall be series 2000, Grade 1 with Option PT4C and PT4D and shall be cast iron.

2. Size door closers to comply with manufacturer's recommendations for door sizes and locations.

3. Supply arms, brackets and plates, as required.

4. Mount on room side of corridor doors.

5. All closers with integral back checks.

6. Entrance and vestibule doors:
Delayed action closer and overhead stop.

7. Other exterior outswinging doors:
   Closer with limiting cushion stop, option PT4G mounted parallel arm.

8. Closers shall be sized 2 through 6; multiple sized closers will not be acceptable.

9. Closers shall be mounted on pull side of the door, except where noted below.

10. Substitute parallel arm mounting where following conditions occur:
    a. Where door swing in full open position would be limited less than 90° due to partition
       construction and closer location.
    b. Where door opens to corridor or lobbies.

11. Closer shall be full rack-and-pinion type and closer arms and brackets shall be steel,
    malleable iron or high strength ductile cast iron. Parallel arm shall have solid forged steel
    arm.

12. Closer shall conform to all requirements of ANSI A156.4 and shall have been tested for one
    million five hundred thousand cycles.

13. Closer shall be equipped with a hydraulic backcheck to permit checking action effective
    between 60° and 85° of door opening.

14. Shall be designed so that a hex head wrench, or similar tool, will operate regulating valves
    for individual control of sweep and latch speeds and hydraulic backcheck adjustments.

15. Closer shall be capable of minimum 50% spring adjustment in closing power.

16. Closers for exterior doors shall have special fluid liquid to allow for temperature change from
    49° C to -1° C without seasonal adjustment of closer.

17. Overhead concealed closer shall be cast iron Type C05022 and have Option PT8D and F
    and shall be same manufacturer as overhead surface mounted closer.

E. Door Closers, Fire Activated:

Fire alarm activated closers shall conform to the requirements of ANSI A156.15 and have
the following features:

1. Closer shall be cast iron and control door closing and latching sequence by hydraulic action.

2. Double lever arm closing action, adjustable hydraulic backcheck and 50% spring power
   adjustment.

3. Closer shall be sized in accordance with manufacturer’s recommendations.

4. Hold open mechanism shall hold door open between 85° and 180° depending on wall and
   frame conditions. Mount closer to provide maximum door opening permitted by building
   construction or equipment.

5. Electronic release shall release door when signaled by smoke detector. Smoke detectors
   shall not be incorporated as an integral part of door closer. Smoke detectors are specified in
   the ELECTRICAL Section.

6. Supply arms, brackets, and plates as required.

7. Mount closer on room side of corridor doors.

8. Opposite swing corridor doors shall be held open no less than 90 degrees. Failure to hold
   at 90 degrees will be considered cause for rejection. The Contractor shall certify the closer
   he proposes to use will hold the door at 90 degrees.

9. Swing free fire alarm activated closer shall allow door to swing free until smoke detector is in
   alarm state and then door shall close.
a. This unit shall have cast iron cylinder and non-critical regulation of closing speed and back-check.

b. The closer arm shall be swing free type with track and low friction roller assembly, shall be attached to door at all times, and will incorporate a "no drift" feature.
   1) Unit shall be capable of being converted to non-swing free function without changing components.
   2) Off/on switch in the unit shall be provided to isolate the closer from the system and make the door self-closing without hold open.

10. All hydraulic door closers including those having electric release shall be of one manufacturer.

F. Butts and Hinges:

Butts and hinges shall meet the requirements of ANSI A156.1. The following table refers to butts and hinges which shall be used on this project except where otherwise specified:

<table>
<thead>
<tr>
<th>Type</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type 1</td>
<td>A2111</td>
</tr>
<tr>
<td>Type 2</td>
<td>A8111</td>
</tr>
<tr>
<td>Type 3</td>
<td>A8112</td>
</tr>
<tr>
<td>Type 4</td>
<td>A8133</td>
</tr>
<tr>
<td>Type 5</td>
<td>A2112</td>
</tr>
<tr>
<td>Type 6</td>
<td>A8121</td>
</tr>
<tr>
<td>Type 7</td>
<td>Wrought steel full mortise architectural grade spring hinge to fit regular gauge cutout and standard template. Hinge shall have two nylon tee bearings for vertical and lateral loads and tension adjustment for spring.</td>
</tr>
</tbody>
</table>

1. Flat button tips on all butts.
2. Size butts to clear trim and allow 180° door swing.
3. Provide butts with "slim line" barrel design.
4. Butt types:
   a. Exterior outswinging doors:
      Type 1 NRP.
   b. Exterior inswinging doors:
      Type 2.
   c. Interior doors thru 900 mm wide:
      Type 4.
   d. Interior doors thru 900 mm wide with closer:
      Type 3.
   e. Interior doors over 900 mm wide:
      Type 2.
   f. Interior doors thru 900 mm wide, for wet areas (Doors to showers, toilets, kitchens, etc. which swing in):
      Type 5.
   g. Interior doors over 900 mm wide for wet areas (Doors to showers, toilets, kitchens, etc. which swing in):
      Type 1.
h. Interior doors requiring swing clear hinges:
   Type 6.

i. Interior doors requiring spring hinges:
   Type 7.

5. Butt quantities:
   a. Doors 1500 mm - 2300 mm in height:
      Three butts.
   b. Doors 2300 mm - 3000 mm in height:
      Four butts.

6. Butt sizes:
   a. 60 mm and thicker doors:
      125 x 125 mm minimum.
   b. 45 mm doors:
      115 x 115 mm.
   c. 35 mm doors:
      90 x 90 mm.
   d. Type 7 butts:
      100 x 100 mm.

G. Door Stops:

1. Wall mounted, L22251X or L22251XT cast brass or bronze. Expansion shield - X. Toggle bolt - XT.
2. Where door swings more than 105° without encountering a wall, install overhead stop C17513.
3. Where exterior door does not swing against a wall, install overhead stop C12511 stop only.
   Do not provide for door with closers except exterior entrance and vestibule doors requiring a size 150 mm closer; see requirements for "Door Closers".
4. Wall mounted stainless steel doorstop for toilets including handicapped, shower and change rooms see Specification 10800, Toilet and Bath Accessories Item 2.03 T.

H. Kick Plates:

1. ANSI A156.6, Type J101.
2. 200 mm high x 50 mm less than door width.
4. 1.27 mm thick stainless steel.

I. Door Pulls, Push Plates, and Bars, ANSI A156.6.

1. Push Plate:
   Type J300, 100 mm x 400 mm, square corner, flat plate, with beveled edges.
2. Push bar:
   Type J500, rectangular bar.
3. Pull:
   Type J400, straight pull with round bar, 25 mm diameter, 205 mm, high, with 70 mm
projection.
Provide cutouts as required for cylinders.

J. **Thresholds**:

ANSI A156.6, Type J601, Aluminium.
1. Provide one piece unit not more than 13 mm high, of style required.
2. Provide required bolt cutouts.

K. **Hardware, Miscellaneous**:

1. ANSI A156.16.
2. Flush bolts to be Type L04081.

L. **Flush Bolts, Automatic**:

1. ANSI A156.3 Type 25 automatic latching and automatic unlatching flush bolt set concealed in the door for wood and hollow metal doors.

M. **Strikes, Dustproof**:

1. ANSI A156.16 L04021.

N. **Door Coordinators**:

1. Automatic spring action.
2. Holder arm shall swing into position when inactive door is open, so as to hold active door sufficiently ajar to permit inactive door to close freely.
3. Holder shall release upon closing of inactive door and permit active door to close. It shall not project into doorway below lower surface of stop bead on head of door frame.
4. Protection plates shall be furnished for top edge of doors at points of contact with working parts of the device.
5. Provide co-ordinating device on double doors with astragals and on double doors receiving closing device on each leaf.
6. Co-ordinator shall extend full width of door between vertical stops and have minimal projection of opening parts not to exceed 30 mm.
7. Co-ordinator shall have absorption mechanism to prevent damage to the active door and co-ordinator if the door is forced closed while it is being held open.
8. Provide filler plates across top of opening.
9. Provide carry bar compatible with above co-ordinator.
   a. Carry bar shall insure proper sequence of operation at all times regardless of speed at which inactive door is opened.
10. Co-ordinator and carry bar shall be UL listed.

O. **Exit Devices**:

Exit devices shall conform with ANSI A156.3 Grade 1; type and function as indicated and shall also conform with the following requirements:
Narrow Stile Doors:
Doors with stiles less than 127 mm.
a. Exit devices shall be touch bar type with touch pad 55 mm wide and be designed to fit in narrow stile door with minimum width of stile 45 mm.
b. Exit device shall be non-handed and be fastened to the door with hex bolts.
c. Unit shall have a bell crank mechanism to provide smooth operation.
d. Conversion kit shall be available for field conversion from hex key to cylinder dogging.
e. This device shall also be available for electric operation in the same design housing as the regular device where specified in hardware sets.
f. Furnish fire label exit devices on label doors.

Wide stile doors:
da. Exit devices shall be touch bar type with touch pad and be designed to operate in door with 130 mm and over wide stiles.
b. Exit device shall be non handed and be fastened to the door with hex bolts.
c. Rim devices shall be field sizeable and have 19 mm throw latch bolt with deadlocking feature.
d. Conversion kit shall be available for field conversion from hex key to cylinder dogging.
e. Mortise exit device shall have 19 mm throw anti-friction latch bolt which is field reversible without removing the lock from the door.
f. Exit devices of this type shall be available with the same case for electric operation where specified in hardware sets.
g. Furnish fire label exit devices on label doors.

NOTE: All exit devices shall be of one manufacturer.

P. Astragale:

Flat steel, U/L listed for labeled doors.

Q. Weather Stripping:

1. At jambs and head:
   Type 1 surface mounted, adjustable, mounted on stops, neoprene gasket in aluminum housing.
2. At bottoms of doors:
   Type 2 surface mounted neoprene sweep in aluminium housing.
3. Meeting edges pairs exterior doors:
   Type 3 surface mounted vinyl fingers mounted in aluminium housing.
4. Head drip on doors other than main entrance doors: Surface mounted aluminium with 65 mm projection.
5. Colour of aluminium shall closely match colour of exterior hardware.

R. Automatic Door Button:

1. Extruded aluminium housing 2.36 mm thick aluminium with maximum 25 mm drop.
   Housing shall be completely closed in back and surface mounted on door.
   Plunger shall be closed cell neoprene.
Where surface mounted Exit Devices are specified, Automatic Door Button shall be mortised into door.

S. Key Cabinet:

1. Size to permit minimum 100% expansion of system.
2. Provide key cabinet made of cold rolled, minimum 1.27 mm furniture steel electro-welded. Doors shall have "no sag" continuous brass-pin piano type hinge and be equipped with chrome plated locking door handles, hook can and two paracentric keys. All locks shall be nickel plated with solid brass pin tumbler cylinder keyed as directed. Key Cabinet and Key Control System shall accommodate all keys for this project plus 50%.
3. Key tags shall consist of two sets:
   - Permanent self-locking and loan key snap hook type with tag colours as follows:
     a. Red fibre marker of the permanent self-locking type approximately 32 mm in diameter on which will be engraved the legend "FILE. KEY MUST NOT BE LOANED."
     b. Also furnish for each hook a white cloverleaf key marker with snap hooks on which shall be engraved "LOAN KEY."
4. The manufacturer of the lock cylinders and locks shall attach a key tag to keys of each lock cylinder and shall mark thereon the respective item number and key change number. Each group of keys shall be contained in a key gathering envelope (supplied by Key Cabinet Manufacturer) in which the lock manufacturer shall include the following information:
   a. Item number, key change number and door number.
   b. The contractor shall furnish the Key Cabinet Manufacturer the hardware and keying schedules and change keys.
5. The Key Cabinet Manufacturer shall set up a three-way cross index system including master keys listing the keys alphabetically, the hooks numerically and the key changes numerically on different coloured index cards.
   a. Index cards shall be typewritten and inserted in a durable binder.
6. Attach the keys to the two (2) sets of numbered tags supplied with the cabinet. (The permanent tag and the loan key tag).
   a. Instruct the Owner in proper use of the system.
   b. The cabinet shall be installed as directed by the Owner.

T. Door Edge Guards

Door edge guards shall be furnished to protect door edges with the required cut-outs for hardware items such as hinges, flush bolts, and locks. Door edge guards shall satisfy fire door ratings.

U. Auxiliary Hardware

1. Auxiliary hardware, consisting of door holders, door stops, and roller latches, shall conform to ANSI A156.16. Lever extension flush bolts shall be of type suitable for metal and wood doors. Dust-proof strikes shall be spring loaded. Other auxiliary hardware of the types listed below, shall conform to manufacturers recommendation and BS/EN codes.

V. Miscellaneous

1. Gasketing:
   Gasketing shall be a compression type seal, EPDM closed cell self-adhesive product for use on steel door frames with steel fire labeled doors. Color shall be white. Seals conforming to
UL 10 B and 1 UL10 C for fire test on door assemblies.

2. Key Control Storage System;
   Key control storage system shall conform to capacity suitable to hold project keys, and shall be properly labeled for key identification.

3. Hardware For Fire Doors:
   Hardware for fire doors shall conform to the requirements of NFPA 80 and NFPA 101.

4. Special Locking Hardware Items:
   Assembly shall contain exit device which complies with both fire and exit requirements. Electric voltage shall not exceed 24 Volts D.C. In hazardous locations, products shall use safe power supplies or shall be pneumatic.

W. Fastenings

Fastenings of proper type, size, quantity, and finish shall be supplied with each article of hardware. Machine screws and expansion shields shall be used for attaching hardware to concrete or masonry. Fastenings exposed to the weather in the finished work shall be of brass, bronze, or stainless steel. The bolts, through bolts, or machine screws and grommet nuts, where used on reverse-bevel exterior doors equipped with half-surface or full-surface hinges, shall employ one-way screws or other approved tamperproof screws. Screws for the jamb leaf of half-mortise and full-surface hinges attached to structural steel frames shall be one-way or other approved tamperproof type.

X. Security Grade Hardware:

Any hardware item indicated as security grade hardware in drawings or in any other documents of the project documents shall be standard product, produced by single manufacturer specialist in this production range. Security grade hardware manufacturer and materials shall be subject to the Engineer approval. Security grade hardware shall be without exposed sharp edges or removable parts.

Y. Card Access Control System

1. The Contractor shall supply, install and commission a "Card Access Control System for each controlled access door. The system shall be proprietary and obtained from manufacturer having representation in Republic of Sudan for minimum 10 years period.

2. The system shall have the following design attributes:
   a. High security infra-red coded cards.
   b. Swipe Operation.
   c. Keypad for PIN numbers
   d. Retina scanner
   e. 2000 - card capacity
   f. Battery back-up unit (48 HRS.)
   g. Remote alarm and computer link facilities for future use.

3. The card readers shall be easy to program by means of key pad or via special programming cards. The reader shall be capable of accepting card only, retina only PIN only or any combination. The card readers located outside shall be of weather resistant type.

4. The card access control system shall be suitable for operation on single phase 220 V 60 Hz and ambient temperature of up to 50°.
PART 3 – EXECUTION

3.1 APPLICATION

A. Hardware shall be located in accordance with NFPA 80 & NFPA 101 requirements. When approved, slight variations in locations or dimensions will be permitted. Application shall be in accordance with manufacturers recommendations. Door Control devices for exterior doors such as closers and holders, shall normally attach to doors with thru bolts and nuts or hex bolts. Electric hardware items and access control devices shall be installed in accordance with manufacturers printed installation procedures.

B. Hardware for Fire Doors and Smoke-Control Door Assemblies:
   Hardware for fire doors shall be installed in accordance with the requirements of NFPA 80. Exit devices installed on fire doors shall have a visible label bearing the marking "Fire Exit Hardware". Other hardware installed on fire doors, such as locksets, closers, and hinges shall have a visible label or stamp indicating that the hardware items have been approved by an approved testing agency for installation on fire-rated doors. Hardware for smoke-control door assemblies shall be installed in accordance with NFPA 105.

C. Door-Closing Devices:
   Door-closing devices shall be installed and adjusted in accordance with the templates and printed instructions supplied by the manufacturer of the devices. Insofar as practicable, doors opening to or from halls and corridors shall have the closer mounted on the room side of the door.

D. Key Control Storage Systems:
   Key control storage system shall be installed where directed.

E. Kick Plates and Mop Plates:
   Kick plates shall be installed on the push side of single-acting doors and on both sides of double-acting doors. Mop plates shall be installed on the pull side of the single acting doors.

F. Auxiliary Hardware:
   Lever extension flush bolts shall be installed at the top and bottom of the inactive leaf of pairs of doors. The bottom bolt shall operate into a dust-proof floor strike or threshold.

G. Weatherseals:
   Weatherseals shall be located as indicated, snug to door face and fastened in place with color matched metal screws after door and frames have been finish painted. Screw spacing shall be as recommended by manufacturer.

H. Gasketing:
   Gasketing shall be installed at the inside edge of the hinge and head and latch sides of door frame. Frames shall be tolerated for a 3 mm clearance between door and frame. Frames shall be treated with tape primer prior to installation.
3.2 OPERATIONAL TESTS

Prior to acceptance of any electrical hardware system, an operational test shall be performed to determine if devices are operating as intended by the specifications. Wiring shall be tested for correct voltage, current carrying capacity, and proper grounding. Stray voltages in lock wiring shall be eliminated to prevent locking devices from releasing in critical situations.

3.3 HARDWARE SCHEDULE

Refer to contract drawings for cross reference to doors/door numbers as detailed below:

3.4 DETAILED HARDWARE SETS

Shall be as proposed by the contractor and approved by the engineer.

End of Section 08710
SPECIFICATION SECTION 08800
GLAZING

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3.3 Protection and Cleaning
1.1 SECTION INCLUDES
A. Glazing for doors, windows, curtain walls and skylights.
B. Mirrors.
C. Glazing materials and accessories.

1.2 SUBMITTALS
A. Product Data: Submit manufacturers technical data for glazing material and fabricated glass product required, including installation and maintenance instructions.
B. Samples: Submit 300 mm x 300 mm samples of each type of glass to be used.
C. Certificates: Submit certificates from manufacturer testing that glass and glazing materials furnished for the project comply with requirements.

1.3 TRANSPORTATION, HANDLING AND STORAGE
A. Protect glass and glazing materials during delivery, storage and handling to comply with manufacturer’s written directions and as required to prevent edge damage to glass, and damage to glass and glazing materials from effects of moisture including condensation, of temperature changes, of direct exposure to sun, and from other causes, including high altitude limitations for insulating glass.

1.4 WARRANTY
A. Submit a written guarantee signed by Manufacturer and Installer of glazing for a period of 4 years from the date of substantial completion. The Guarantee shall cover the replacement of defective materials and workmanship as directed by the Engineer.

1.5 QUALITY ASSURANCE
A. Glazing Standards: Comply with recommendations of Flat Glass Marketing Association (FGMA) - Glazing Manual and Sealant Manual except where more stringent requirements are indicated. Refer to those publications for definitions of glass and glazing terms not otherwise defined in this Section or other referenced standards.
B. Safety Glazing Standard: Where safety glass is indicated, provide type of products which comply with ANSI Z97.1.
C. Provide insulating glass units permanently marked either on spacers or at least one component pane of unit with appropriate certification label of inspecting and testing organizations.

1.6 PROJECT CONDITIONS
A. Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturer or when joint substrates are wet due to rain, frost, condensation or other cause.
B. Install sealant at ambient and substrate temperatures permitted by sealant manufacturers.
2.1 GLASS PRODUCTS - GENERAL

A. Primary Glass Standard: Provide primary glass which complies with ASTM C 1036 requirements, including those indicated by reference to type, class, quality, and if applicable, form, finish, mesh and pattern.

B. Heat-Treated Glass Standard: Provide heat-treated glass which complies with ASTM C 1084 requirements, including those indicated by reference to condition, type, quality, class, and if applicable, form, finish, and pattern.

C. Sizes: Fabricate glass to sizes required for glazing openings indicated, with edge clearances and tolerances complying with recommendations of glass manufacturer. Provide thicknesses indicated or, if not otherwise indicated, shall be as indicated in the standards and as recommended by glass manufacturer for application indicated, but not less than 6 mm thick for windows and 12 mm for doors (single glazing).

2.2 GLASS

A. Provide glass to meet specified glass performance requirements.

B. Provide glass types for installations approved by the Owner.

C. Fabricate curved glass to true radius within tolerances specified for frame in which it will be installed.

D. Float Glass: To meet specified requirements of ASTM C1036, Type I, Class 1, Quality Q3 (transparent flat, clear, glazing select); or equivalent of BS 952, Part 1.

E. Clear Wired Glass: Polished Georgian wired plate, 6 mm thick, to meet specified requirements of ASTM C1036, Type II, Class 1, Form 1, quality Q8, Mesh M² (Square); or equivalent of BS 952, Part 1.

F. Tempered Glass: Heat treated, fully tempered, safety glass for performance specified in ANSI 297.1, and to meet specified requirements of ASTM C1048; or equivalent of BS 952, Part 1, for performance in accordance with BS 6206.

G. Tinted (Heat Absorbing): To meet specified requirements of ASTM C1036, Condition A, Type 1, Class 2, Quality Q3 float or tempered glass as indicated, and of color approved by Owner.

H. Leaded glass, transparent, leaded for radiation protection with thickness indicated.

I. Reflective glass (Type FG-E) float type, heat strengthened, tempered, bronze coating on inner surface, light transmittance of 12 percent, shading coefficient of 0.35, with thickness indicated.


K. Double Glazing: Provide pre-assembled units consisting of sealed panes of glass enclosing a hermetically sealed dehydrated air space and complying with ASTM E 774 for performance classification indicated as well as with other requirements specified for glass characteristics, air space, sealing system, sealant, spacer material, corner design, desiccant.
L. FIRE RESISTANT GLASS: Products carry UL Classifications as to Fire Resistance. Tests performed in accordance with UL 9, UL 10B, UL 10C, ASTM E2074, ASTM E2010, CSFM 43.7, NFPA 252, NFPA 257, UBC 43.2, UBC 43.4, UBC 7-2, UBC 7-4, CAN4 S-104 and CAN4 S-106.

2.3 PARTICULAR NOTES:
A. All low-E to be pirolotically glass.
B. The ceramic frit colour is to the architects approval.
C. Obscured glass type and colour is to the architects approval.
D. Glass shall conform to the requirements of ASTM C1036 quality Q3 unless otherwise specified. Heat treated glass shall conform to the requirements of ASTM C1048. Tempered glass shall also conform to ANSI Z97.1-984. All heat treating shall be by the horizontal process, and processed in such a manner as installed on the building.
E. All the silicone used for the double glazing or structural bonding to be structural silicone. All spacers used in double glazing should be brndable type and filled with desicant.
F. Insulating glass shall comply to the following standards:
   E773 test method for seal durability of sealed insulating glass units.
   E774 specification for seal insulating glass units.
   E546 test method for frost point of sealed insulating glass units.
   E576 test method for Dew/frost of sealed insulating glass units vertical position.
G. Laminated glass shall comply to ASTM C1036-90
H. 10 years warranty on the double glazing units and 5 years on the laminated glass to be submitted from the glass fabricators by the name of the project upon the completion.
I. Original glass certificate of origin and 10 years warranty on the coating from the glass agent should be submitted by the name of the project upon the completion.

2.4 MIRRORS
A. Type I, Class I, Quality q², Clear float mirror, fully silvered electrically copper-plated, 6 mm thick, exposed edges ground and face corners cased, guaranteed against silver spoilage for 15 years.
B. Size and location of mirrors shall be as indicated on Drawings.

2.5 GLAZING MATERIALS AND ACCESSORIES
A. Glazing Gaskets: Dense elastomeric seal gaskets shall be continuous neoprene or polyvinyl chloride extrusions, of 50 Shore A durometer hardness plus or minus 5 complying with ASTM C 864.
B. Lock-Strip Gaskets: Conform to ASTM C 542, neoprene extrusions of required size and shape. Frames fabricated with injection molded corners. Provide with separate lock (zipper) strips, Shore A durometer 10 points harder than gasket body.
C. Setting Blocks: Neoprene, EPDM or silicone blocks as required for compatibility with glazing sealants, 80 to 90 Shore A durometer hardness.
D. Spacers: Neoprene blocks, 40 to 50 Shore A durometer hardness, self-adhesive on one face only; compatible with sealant used. Use EPDM spacers for units set with silicone
glazing sealant.

E. Joint Cleaner, Primer and Sealer: As recommended by the glazing manufacturer.

F. Compressible Filler Rod: Closed-celled or a waterproof-jacketed rod stock of synthetic rubber or plastic foam, compatible with sealants used, flexible and resilient, with 34.5 to 68.9 kPa compression strength for 25 percent deflection.

G. Preformed Butyl-Polyisobutylene Glazing Tape: Provide manufacturer's standard solvent-free butyl-polyisobutylene formulation with a solids content of 100 percent; complying with AAMA A 804.1; in extruded tape form; non-staining and non-migrating in contact with non-porous surfaces; packaged on rolls with a release paper on one side; with or without continuous spacer rod as recommended by manufacturers of tape and glass for application indicated.

H. Sealants: Conform to Section 07900 - SEALANTS.
PART 3 – EXECUTION

3.1 PREPARATION

A. Clean glazing channels, stops and other framing members to receive glazing materials of obstructions and deleterious substances which might impair the work. Remove coatings which are not firmly bonded to substrates. Remove lacquer from metal surfaces where elastomeric sealants are indicated for use. Comply with manufacturer's instructions for final wiping of surfaces immediately before application of primer and glazing media.

3.2 INSTALLATION

B. General:
1. Unless otherwise shown or specified, comply with recommendations and requirements of the FGMA Glazing Sealing Systems Manual and Glazing Manual. For the installation of all glass comply with glass manufacturer's and glazing materials manufacturer's written instructions and recommendations.
2. Provide watertight and airtight installation of each piece of glass, so as to withstand temperature changes and wind loading normal at the site.
3. Operating sash and doors shall withstand impact loading without failure of any kind including loss or breakage of glass, failure of sealants or gaskets to remain watertight and airtight, and deterioration of glazing materials.
4. All butt-joint glazing according to the glass manufacturer's recommendations.

C. Inspection:
1. Inspect each piece of glass immediately before installation. Do not install any pieces which are improperly sized or have damaged edges, scratches or abrasion or any other evidence of damage.
2. Use suction cups to shift glass units within openings; do not drift glass with pry bars. Remove labels from glass immediately after installation.

D. Setting Blocks:
1. Locate setting blocks at sill rabbet one-quarter in from each end of the glass, unless otherwise recommended by the glass manufacturer.
2. Use blocks of proper size to support the glass in accordance with manufacturer's recommendations. Set blocks in thin course of sealant which is acceptable.

E. Spacers:
1. Provide spacers for all glass sizes larger than a combined total of 1.27 m or more for any two adjacent sides to separate glass from stops, except where continuous glazing gaskets are provided.
2. Locate spacers no farther than 600 mm apart and no closer than 300 mm to a corner. Place spacers opposite one another. Make bite of spacer on glass a nominal 6 mm or greater.

F. Set units of glass in each series with uniformity of pattern, draw, bow and similar characteristics.

G. Provide compressible filler rods or equivalent back-up material, as recommended by sealant and glass manufacturers, to prevent sealant from extruding into glass channel weep systems and from adhering to joints back surface as well as to control depth of sealant for optimum performance, unless otherwise indicated.
H. Sealants:
   1. Force sealants into glazing channels to eliminate voids and to ensure complete bond of sealant to glass and channel surfaces.
   2. Tool exposed surfaces of sealants to provide a substantial "wash" away from glass. Install pressurized tapes and gaskets to protrude slightly out of channel, so as to eliminate dirt and moisture pockets.
   3. For further requirements refer Section 07900 - SEALANTS.

I. Glazing Gaskets:
   Miter-cut and seal joints of glazing gaskets in accordance with manufacturer's written instructions.

J. Lock-Strip Gaskets:
   1. Comply with gasket manufacturer's written instructions and recommendations. Miter-cut corners of loose zipper strips slightly longer to provide permanent compression at joints.
   2. Use special tool to install and remove filler strips; lubricate in accordance with manufacturer's instructions.
   3. Comply with glass manufacturer's written instructions for the use of setting blocks, liquid or tape sealants, and weep holes in the glazing recess of lock strip gaskets.

3.3 PROTECTION AND CLEANING

A. Protect glass from breakage immediately upon installation by use of crossed streamers or ribbons attached to framing and held away from glass. Do not apply markings to surfaces of glass. Remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. Cover glass as required to protect it from additives that might abrade the glass surface. If, despite such protection, contaminating substances do come into contact with glass, remove immediately by method recommended by glass manufacturer.

C. Remove and replace glass which is broken, chipped, cracked, abraded or damaged in other ways during construction period, including natural causes, accidents and vandalism.

D. Maintenance: Maintain glass in a reasonably clean condition during construction.

E. Cleaning: Wash glass on both faces not more than 4 days prior to acceptance. Comply with instructions and recommendations of the glass manufacturer and glazing materials manufacturer for cleaning in each case.
### Division 09 00 00

**Finishes**

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<tr>
<td>09 22 00</td>
<td>Portland Cement Plaster</td>
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<tr>
<td>09 25 00</td>
<td>Gypsum Board</td>
</tr>
<tr>
<td>09 26 50</td>
<td>Fibrous Plaster</td>
</tr>
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## SPECIFICATION SECTION 09206

### METAL FURRING AND LATHING

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PART 1 – GENERAL

1.1 WORK INCLUDED
A. Metal furring, and lathing as required for cement plaster walls and ceilings.
B. Install access panels within metal furring and lathing system.

1.2 RELATED OBLIGATIONS
A. The general requirements under Division 1 apply to work specified in this Section.
B. Examine all the other Sections of the Specification for requirements which may affect work of this Section.
C. Co-ordinate work with all other trades affecting, or affected by activities of this Section. Co-operate with such other trades to assure the steady progress of all operations under the Contract.

1.3 RELATED WORK
A. Section 09220 - Portland Cement Plaster

1.4 APPLICABLE STANDARDS
A. ANSI A42.4 - Interior Lathing and Furring.
PART 2 – PRODUCTS

2.1 FURRING MATERIALS

A. Furring Channels: Minimum 25 gauge galvanized sheet steel; 22mm deep; standard width; lengths as required.

B. Fastening and Anchorage Devices: Approved devices of type and size to suit application and to rigidly secure furring members in place.

2.2 CEILING FURRING MATERIALS

<table>
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<tr>
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<tr>
<td>915 mm</td>
<td>1220 mm</td>
<td>38 x 13 mm</td>
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<tr>
<td>1220 mm</td>
<td>915 mm</td>
<td>38 x 13 mm</td>
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<tr>
<td>1220 mm</td>
<td>1220 mm</td>
<td>38 x 13 mm</td>
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<tr>
<td>1525 mm</td>
<td>915 mm</td>
<td>50 x 8 mm</td>
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<tr>
<td>1830 mm</td>
<td>610 mm</td>
<td>50 x 15 mm</td>
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A. Main Carrying Channel: Minimum 16 gauge galvanized sheet steel: 50 mm size; lengths as required.

B. Furring Channels: Minimum 25 gauge galvanized sheet steel: 22.2 mm deep x 32 mm wide; lengths as required.

C. Hangers: Galvanized steel, of size and type to suit application and to rigidly secure ceiling system in place, with maximum deflection of 1/360.

D. Lateral Bracing: Minimum 16 gauge cold rolled steel channels with galvanized prime painted coating; 19 mm x 10 mm size; maximum practical lengths.

E. Anchorage and Fastening Device: Approved devices of type and size to suit application and to rigidly secure ceiling furring members in place.

2.3 LATHING MATERIALS AND ACCESSORIES

A. Metal Lath: Flat rib 10 mm rib; with galvanized or rust inhibitive coating; of weight to suit application.

B. Inside corner mesh: Minimum 26 gauge steel with galvanized or rust inhibitive coating; perforated or expanded flanges or clips shaped so as to permit complete embedding in plaster; minimum 50 mm x 50 mm size.

C. Anchorages: Tie wire, nails, screws and other approved metal supports, of type and size to suit application and to rigidly secure lathing materials in place; galvanized rust inhibitive coated.
PART 3 – EXECUTION

3.1 INSTALLATION - GENERAL
A. Erect metal furring and lath as required for cement plaster in accordance with ANSI A42.4, unless indicated otherwise herein.
B. Install members true to lines and levels and to provide surface flatness with maximum variation of 3mm in 3m.

3.2 HOLLOW METAL FRAMES AND ACCESS PANELS
A. Install hollow metal frames and rigidly secure in place.
B. Install metal access panels and rigidly secure in place.
C. Co-ordinate the installation of bucks, anchors, blocking, electrical, and mechanical work which is to be placed in or behind wall framing. Allow such items to be installed after framing is complete.

3.3 WALL FURRING
A. Erect wall furring directly attached to concrete block and concrete walls.
B. Erect furring channels horizontally/vertically as approved. Secure in place on alternate channel flanges at maximum 610 mm on centre.
C. Space furring channels maximum 600 mm on centre.

3.4 CEILING FURRING
A. Install ceiling furring at heights indicated on Drawings. Erect after above ceiling work is complete. Co-ordinate the location of hangers with other work.
B. Install ceiling furring independent of walls, columns, and above ceiling work. Securely anchor hangers to structural members or embed in structural slab.
C. Space main carrying' channels as specified.
D. Securely fix carrying channels to hangers to prevent turning or twisting and to develop full strength of hangers.
E. Reinforce openings in ceiling suspension system, which interrupt main carrying channels or furring channels, with lateral channel bracing. Extend bracing minimum 610 mm past each end of openings.
F. Laterally brace suspension system where required.

3.5 LATHING MATERIALS
A. Apply metal lath taut, with long dimension perpendicular to supports. Place projections of lath against supports.
B. Lap ends minimum 25 mm. Adequately secure end laps with tie wire where they occur between supports.
C. Lap sides of diamond mesh lath minimum 38 mm.
D. Securely attach metal lath to metal supports using tie wire at maximum 152 mm on centre.
E. Securely attach metal lath to concrete joists using wire hair pins, hooks, or loops. Ensure anchorages are securely embedded in concrete or attached to concrete reinforcing steel.

F. Continuously reinforce all internal angles with cornerite, except where the metal lath forms the angle reinforcement. Fasten cornerite at extreme edges only.

End of Section 09206
SPECIFICATION SECTION 09220
PORTLAND CEMENT PLASTER

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1.5  Job Conditions

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2.1  Plaster Accessories
2.2  Portland Cement Plaster

PART 3  EXECUTION
3.1  Installation of Lathing and Furring - General
3.2  Installation of Ceiling Suspension Systems
3.3  Metal Lathing
3.4  Installation of Plastering Accessories
3.5  Plaster Application
3.6  Cutting and Patching
3.7  Cleaning and Protection
PART 1 – GENERAL

1.1 SECTION INCLUDES
A. Plaster accessories including metal lath and plastering beads as well as control joints.
B. Cement plaster.

1.2 SUBMITTALS
A. Manufacturer's Certificates: Submit manufacturer's certificates showing compliance with the specified material requirements and installation and workmanship instructions.
B. Samples: Submit 300 mm long samples of the proposed accessories.

1.3 TRANSPORTATION, HANDLING AND STORAGE
A. Except for sand and water, deliver materials to the site in sealed containers or bags fully identified with manufacturer's name, brand, type and grade. Store materials in a dry, well-ventilated space, under cover, off the ground, and away from surface subject to dampness or condensation.
B. Deliver accessories in their original containers bearing the name of the manufacturer and production identification.

1.4 QUALITY ASSURANCE
A. Allowable Tolerance for Finished Work: For flat surfaces, do not exceed 3 mm in 3 meters for bow or warp of surface and for plumbness or level.
B. Mock-up Installation: Prior to installation of plaster work, provide sample mock-up panels using materials specified for final work. Build sample panels at site, of full thickness and approximately 1.2 x 1.2 m.
C. Demonstrate the proposed range of color, texture and workmanship to be expected in the completed work, and submit to the Engineer for review. Retain sample panels construction as a standard for judging completed plaster work. Do not alter, move or destroy sample panel until plastering work is completed. Provide a sample panel for interior and exterior portland cement plaster and plaster on metal lath.

1.5 JOB CONDITIONS
A. Protection:
   1. General: Protect contiguous work from moisture deterioration and soiling, which may result from plastering operations. Provide temporary covering and whatever other provisions may be necessary to minimize harmful spattering of plaster on other work.
   2. Finished door and window frames and other surfaces which do not receive a plaster finish shall be well protected during plaster application.
B. Environmental Conditions:
   1. General: Protect plaster against uneven and excessive evaporation and from strong flows of dry air, both natural or artificial. Apply and cure plaster as required by climatic conditions to prevent rapid dry-out. Provide suitable coverings, moist curing, barriers to deflect sunlight and wind, or combination of these as required.
   2. Ventilation: Provide adequate ventilation to properly dry interior plaster during and subsequent to its application.
2.1 PLASTER ACCESSORIES

A. Galvanized steel furring, lathing and other plaster accessories shall conform to the material provisions of ASTM C 841 and ANSI A42.3. Plaster accessories shall include but not limited to the following:

- **Metal Corner Beads:** Fabricated from galvanized sheet, 5 mm radius bead with 38 mm wide expanded type flanges.
- **Strip Reinforcement:** Smooth edge strips of expanded metal lath fabricated from galvanized steel sheet, with uncoated steel painted after fabrication.
- **Casing Beads:** Square-edged style, with short or expanded flanges to suit kinds of plaster bases galvanized steel.
- **Curved Casing Beads:** Square-edged style, fabricated from aluminum coated with clear plastic, preformed into curve of radius indicated on the Drawings.
- **Control Joints:** Prefabricated, galvanized steel one-or two-piece type as required. Provide removable protective tape on plaster face of control joints.
- **Metal Corner Reinforcement:** Expanded large mesh diamond lath fabricated from welded wire mesh from 1.2 mm diameter galvanized wire, specially formed to reinforce corners of portland cement plaster where exposed while allowing full plaster encasement.
- **Expanded Metal Lath:** Galvanized steel diamond mesh complying with ASTM C 847 and shall have a minimum weight of 1.85 kg/m².

B. Coordinate the depth of accessories with the thickness and number of plaster coats required in accordance with the manufacturer's recommendations and as directed by the Engineer.

2.2 PORTLAND CEMENT PLASTER

C. Portland cement plaster shall have a minimum thickness of 20 mm in a double coat provided using but not limited to the following materials:

1. **Base Coat Cement:** Portland cement, conforming to ASTM C 150, Type I.
2. **Finish Coat Cement:** Portland cement, conforming to ASTM C 150, Type I.
3. **Factory-Prepared Finish Coat:** Manufacturer's standard product requiring only the addition of water; white in color unless otherwise indicated.
4. **Lime:** Special hydrated lime for finishing purposes, conforming to ASTM C 206, Type S.
5. **Sand Aggregate for Base Coat:** Conform to the requirements of ASTM C 897.
6. **Aggregate for Finish coat:** Conform to ASTM C 897, manufactured or natural sand, white in color or as required to match the Engineer sample.
7. **Water for Mixing and Finishing Plaster:** Potable, free of substances, capable of affecting plaster set or of damaging plaster, lath or accessories.
8. **Bonding Agents:** Conform to ASTM C 932.

D. Portland cement plaster mixes and compositions:

1. **General:** Comply with ASTM C 926 for portland cement plaster base and finish coat mixes as applicable to plaster bases, materials and other requirements indicated. Submit samples of materials used for the approval of the Engineer as well as mix design.
2. **Base Coat:** Proportion materials for respective base coats in parts by volume for cementitious materials and in parts by volume for sum of cementitious materials for
aggregates to comply with following requirements for each method of application and plaster base as required. Adjust mix proportions indicated herein within the limits specified to attain workability as follows:

a. Two-coat Work over Concrete Unit Masonry: Base coats shall be one part portland cement: 3/4 to 1 1/2 parts lime: 3 to 4 parts sand.

3. Finish Coat: Proportion materials for finish coats in parts by volume for cementitious materials for aggregates with one part portland cement: 3/4 to 1 1/2 parts lime, 3 parts sand or one part portland cement, one part masonry cement, 3 parts sand, or as required.
PART 3 – EXECUTION

3.1 INSTALLATION OF LATHING AND FURRING - GENERAL
A. Install interior lathing and furring materials indicated for plaster to comply with ASTM C 841.
B. Install lathing and furring materials indicated for Portland cement plaster to comply with ANSI A42.3.
C. Install supplementary framing, blocking, and bracing at terminations of work for support of fixtures, equipment services, heavy trim, grab bars, toilet accessories and similar work in accordance with details indicated on Drawings or approved shop drawings.
D. Isolation: Where lathing and metal support system abuts building structure horizontally, and where partition/wall work abuts overhead structure, isolate the work from structural movement sufficiently to prevent transfer of loading into the work from the building structure. Install slip or cushion type joints to absorb deflections but maintain lateral support.
E. Frame both sides of control and expansion joints independently, and do not bridge joints with furring and lathing or accessories.

3.2 INSTALLATION OF CEILING SUSPENSION SYSTEMS
A. Coordinate installation of ceiling suspension system with installation of overhead structural systems, ducting and catwalks to ensure that inserts and other structural anchorage provisions have been installed to receive ceiling hangers in a manner that will develop their full strength and at spacings required to support ceiling.
B. Furnish concrete inserts, and other devices indicated, to other trades for installations well in advance of time needed for coordination with other work.
C. Attach hangers to structure above ceiling to comply with ML/SFA - Specifications for Metal Lathing and Furring as well as with referenced standards.
D. Install ceiling suspension system components of sizes and spacings indicated but not in smaller sizes or greater spacings than that required by the referenced lathing and furring installation standards.

3.3 METAL LATHING
A. Install expanded metal lath for the applications where plaster base coats are required. Provide appropriate type, configuration and weight of metal lath selected from materials required which comply with referenced lathing installation standards.

3.4 INSTALLATION OF PLASTERING ACCESSORIES
B. General: Comply with referenced lathing and furring installation standards for provision and location of plaster accessories of type indicated. Miter or cope accessories at corners; install with tight joints and in alignment. Attach accessories securely to plaster bases to hold accessories in place and alignment during plastering.
C. Accessories:
   2. Casing Beads: Install at terminations of plaster work, except where plaster passes behind and is concealed by other work and where metal screed, bases or metal frames act as casing beads.
3. Control Joints: Install at locations indicated, or if not indicated, at spacings and locations required by referenced standard and recommended by plaster manufacturer and approved by the Engineer.


3.5 PLASTER APPLICATION

D. Prepare monolithic surfaces for bonded base coats and use bonding compound or agent to comply with requirements of referenced plaster application standards for conditioning of monolithic surfaces.

E. Tolerances: Do not deviate more than 3 mm in 3000 mm from a true plane in finished plaster surfaces, as measured by a 3000 mm straightedge placed at any location on surface.

F. Grout hollow metal frames and similar work occurring in plastered areas, with base coat plaster material, and prior to lathing where necessary. Except where full grouting is indicated or required for fire-resistance rating, grout 150 mm lengths at each anchorage.

G. Sequence plaster application with the installation and protection of other work, so that neither will be damaged by the installation of the other.

H. Plaster finish with metal frames and other built-in metal items or accessories which act as a plaster ground, unless otherwise indicated. Where plaster is not terminated at metal by casing beads, cut base coat-free from metal before plaster sets and groove finish coat the juncture with metal.

I. Apply thickness and number of coats of plaster as indicated or as required by referenced standards, and as per manufacturer's recommendations.

1. Cement Plaster: Base coat shall be 20 mm thick for concrete and CMU. Finish coat shall be 3 mm.

2. Gypsum Plaster (for internal use): Base coat shall be 12 mm thick. Finish coat shall be 3 mm.

J. Concealed Plaster: Where plaster application will be concealed by wood panelling, above suspended ceilings and similar locations, finish-coat may be omitted. Where plaster application will be concealed behind cabinets and similar furnishings and equipment, apply finish-coat. Where plaster application will be used as a base for adhesive application of tile and similar finishes, omit finish-coat and coordinate thickness with overall dimension as shown and comply with tolerances specified.

3.6 CUTTING AND PATCHING

A. Cut, patch, point-up and repair plaster as necessary to accommodate other work and to restore cracks, dents and imperfections. Repair or replace work to eliminate blisters, buckles, excessive crazing and check cracking, efflorescence and similar defects, and where bond to the substrate has failed.

B. Sand smooth-trowelled finishes lightly to remove trowel marks and arises.

3.7 CLEANING AND PROTECTION

A. Remove temporary protection and enclosure of other work. Promptly remove plaster from door frames, windows, and other surfaces which are not to be plastered. Repair floors, walls and other surfaces which have been stained or otherwise damaged during the plastering work. When plastering work is completed, remove unused materials, containers and
equipment and clean remove unused materials, containers and equipment and clean floors of plaster debris.

B. Provide final protection and maintain conditions which ensure plaster work being without damage or deterioration at the time of substantial completion.

End of Section 09220
SPECIFICATION SECTION 09250
GYPSUM BOARD

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2.2        Gypsum Board
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PART 3    EXECUTION
3.1        Preparation of Framing Systems
3.2        Installation of Framing Systems
3.3        Board Installation
3.4        Adjustment and Cleaning
3.5        Protection of Work
PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Ceiling suspension system, wall framing and furring systems for dry walls.
B. Gypsum board for walls and ceilings.
C. Miscellaneous materials and the related accessories as shown on Drawings and as specified in this section.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's product specification and installation instructions for each gypsum drywall component, including other data as may be required to show compliance with these Specifications.
B. Samples: Submit manufacturer's samples for the Engineer approval.
C. Shop Drawings: Submit complete shop drawing of layout and details of ceiling and/or partitions for the Engineer approval.
D. Mock-Up: Install a full size mock-up showing different elements completed for dry wall partitions and ceilings.

1.3 TRANSPORTATION, HANDLING AND STORAGE

A. Comply with the requirements of transportation, handling and storage specified in ASTM C 840.

1.4 QUALITY ASSURANCE

A. Job Mock-Up: Prior to the installation of gypsum board work, erect one sample, 1500 x 1500 mm as directed by the engineer. Obtain the Engineer's approval of the mock-up before proceeding with installation. Retain mock-up during construction as a standard for judging completed gypsum board work.
2.1 METAL SUPPORT SYSTEM

B. Ceiling Support System:
1. Main Runners: Steel channels with rust inhibitive coating (Galvanized), hot or cold-rolled, minimum nominal thickness 0.6 mm with 40 mm flanges and channel web of suitable size.
2. Hanger Wire: Conform to ASTM C 514, soft, Class 1, galvanized.
3. Hanger Rods and Flats: Mild steel with zinc or equally rust inhibitive coating for rods and zinc or rust-inhibitive paint finish for flats.
4. Furring Members: Conform to ASTM C 645, not less than 0.6 mm thick, hat-shaped with 19 mm flanges.
5. Furring Anchorage: Conform to ASTM C 754, 1.6 mm diameter galvanized wire ties, manufacturer's standard wire-type clips, bolts, nails or screws.
6. Direct Suspension System: Manufacturer's standard zinc-coated or painted steel system of furring runners, tees, and accessories designed for concealed support of gypsum dry wall ceilings.

C. Wall/Partition Support Materials:
1. Studs: Formed from steel sheets conforming to ASTM C 645 with manufacturer's standard protective coating. C-shaped studs, 0.6 mm thick with web dimension compatible with thickness of wall as shown on Drawings. Stud flanges shall be 30 mm wide. Provide holes and knockouts for utilities.
2. Furring Members: Conform to ASTM C 645, 0.6 mm thick, hat-shaped.

2.2 GYPSUM BOARD

A. Regular gypsum board for General Use: for walls conform to the requirements of ASTM C 36+, Grade R and for ceilings conform to the requirements of ASTM C 1395+ with thick as indicated on drawings and bill of quantities, with tapered or beveled edges.

B. Moisture-resistant gypsum board for Toilets, Kitchens and Similar Wet Areas: Conform to ASTM C 630+, with thick as indicated on drawings and bill of quantities, with tapered or beveled edges.

C. Fire retardant wall board: Where indicated on Drawings, use Type X and shall meet the requirement of ASTM 1396/C 36.

2.3 MISCELLANEOUS MATERIALS

A. Fasteners:
1. Screws: Self-drilling, self-tapping bugle head for use with power-driven tool and of the type recommended by board manufacturer for the intended application.
2. Fasteners for furring members: Type and size shall be as recommended by furring manufacturer for the substrate and intended application.

B. Joint Treatment Materials:
1. Joint reinforcing tape: Perforated type, width range between 45 mm and 60 mm, and 0.3 mm thick.
2. Joint compound: As recommended by the board manufacturer for the intended application and in accordance with ASTM C475.

3. Concealed Sealants: Mastic type, non-shrink, non-drying, non-migrating, and non-staining sealant.


C. Trim Accessories:
   1. General: Provide manufacturer's standard trim accessories of types indicated for drywall work, formed of galvanized steel unless otherwise indicated, with either knurled and perforated or expanded flanges for nailing or stapling, and beaded for concealment of flanges in joint compound.
   2. Provide corner beads, L-type edge trim-beads, U-type edge trim-beads, special L-kerf type edge trim-beads, and one-piece control joint beads as required.
PART 3 – EXECUTION

3.1 PREPARATION OF FRAMING SYSTEMS
A. Ceiling Anchorages: Coordinate work with the structural ceiling work to insure that the inserts as well as the other structural anchorage provisions have been installed to receive ceiling hangers.

3.2 INSTALLATION OF FRAMING SYSTEMS
A. Ceiling Support System: Secure hangers to structural support by connecting directly to structure where possible, otherwise connect to inserts, clips or other anchorage devices and fasteners as indicated.
B. Wall Support System: Align top and bottom tracks to assure plumb wall. Secure track with suitable fasteners at a maximum of 600 mm on center. Position studs in track at 600 mm on center spacing.

3.3 BOARD INSTALLATION
A. Locate exposed end-butt joints as far from center of walls and ceilings, and stagger not less than 300 mm in alternate courses of board.
B. Install ceiling boards in the direction and manner which will minimize the number of end-butt joints, and which will avoid end joints in the central area of each ceiling.
C. Install wall board vertically to avoid end-butt joints wherever possible.
D. Install boards with face side out. Do not install imperfect, damaged or damp boards. Butt boards together for a light contact at edges and ends with not more than 1.5 mm open space between boards. Do not force in place.

3.4 ADJUSTMENT AND CLEANING
A. When face of paper for gypsum board is punctured, a new screw shall be driven approximately 30 mm from puncture and fill damaged surface with compound.
B. Fill cracks with compound and finish smooth and flush.

3.5 PROTECTION OF WORK
A. The required procedures for protecting drywall work from damage and deterioration during remainder of construction period shall be as recommended by board manufacturer or dry wall installer and approved by the Engineer.

End of Section 09250
### SPECIFICATION SECTION 09265

**FIBROUS PLASTER**

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PART 1 – GENERAL

1.1 WORK INCLUDES
A. The work includes design, fabrication, supply, transportation to job site and installation of the proposed fibrous plaster work as specified in this Section and as shown and scheduled on the drawings.

B. The work under this Section includes but is not limited to the following:
   1. Fibrous plaster: Plane faced/flat bed ceiling to areas as scheduled on drawings.
   2. Decorative cornices: To profiles as shown on the drawings.
   3. Mouldings: Decorative planted mouldings/features to the ceilings.

1.2 RELATED SECTIONS
A. Examine all the other Sections of the Specifications for requirements which may affect work of this Section.

B. Co-ordinate work with all other trades affecting, or affected by activities of this Section. Co-operate with such other trades to assure the steady progress of all operations under the Contract.

1.3 SHOP DRAWINGS
A. Shop drawings to indicate the following:
   1. Plans showing plane faced/flat bed ceiling.
   2. Location of cornices and decorative mouldings.
   3. Sizes and profiles of all fibrous plaster mouldings.

B. Based upon the information provided in Tender Drawings the Contractor shall produce fabrication and production drawings. These shall identify the method of fixing, joint treatment, sub-frame and support mechanisms. The design of all connections to the structure shall be subject to the approval of the Architect/Engineer.

C. The Contractor shall also produce for engineer's approval setting out drawings of fibrous applied/plaster mouldings for each bay area based upon the arrangement shown on reflected ceiling plans.

D. The Contractor shall not start production work without written approval by the engineer.

1.4 QUALITY ASSURANCE
Fibrous plaster shall be installed in such a way as to:

A. Avoid condensation and pattern staining.

B. Comply with any fire regulations relevant to the areas of installation.

C. Avoid any "bleeding" of light through joints, junctions, cut-outs, etc., to room side from those parts of light fittings above the underside, or finished side, of the fibrous plaster.

D. Comply with all relevant parts of CP 290, 1973, applying to fibrous plaster moulding/fixing and finishing.

E. Avoid all cracks, chips, dents, and other defects in the smooth finished surface, all damaged areas will be replaced/repaired at the expense of the Contractor.
F. Ensure that the design and fixing of the fibrous plaster are such that no flexing or resonance occur due to air movement through grilles or vents in the plaster or near it.

1.5 STORAGE AND HANDLING

A. Programme delivery so that fibrous plaster will not be subject to avoidable changes in humidity.

B. Transport under total weather protection.

C. Off-load directly into conditions of storage suited to the moisture content of the fibrous plaster and maintain those conditions.

D. Prevent distortion of panels during transit, handling, storage and fixing.

E. Protect from damage during delivery, storage, handling, erection and construction activities. All damaged items shall be taken down and renewed at the discretion of the Architect/Engineer. Any work disturbed in consequence shall be made good at the Contractor's expense.

1.6 FABRICATION

A. Undertake all fabrication in humidity controlled workshop.

1.7 MOCK-UP

A. The Contractor shall prepare three mock-ups for Architect/Engineer's approval as follows:
   1. The mock-ups will be true representation of finished product on site.
   2. Typical fibrous plaster (full size) cornice moulding 1000mm long minimum.
   3. 1000 x 1000mm flat bed panel of thickness proposed for the project with AC grille/diffuser if applicable.
PART 2 – PRODUCTS

2.1 GENERAL
A. Reinforced gypsum (fibrous plaster) shall be fabricated in accordance with the requirements stated below and comply to the applicable standards and practices. The gypsum units shall be fixed in location as indicated on the drawings.

2.2 MATERIALS
A. Gypsum Plaster: Gypsum Plaster shall be from an approved European source complying with the requirements of BS 1191, Parts 1 and 2.
B. Water: Water shall be clear, clean, potable fresh water free from all deleterious matter, silt, alkali, salts and other impurities and shall comply with the requirements of BS 3148.
C. Hessian Scrim: Hessian scrim shall be used to provide a durable consistance and to avoid breakage and cracking.
D. Reinforcing Laths: In gypsum plates in excess of 700 X 700mm, decorative mouldings or instructed, timber reinforcing laths of suitable section shall be incorporated in the design to minimize bending and deflection.
E. Hessian Fibres: Hessian fibres shall be utilised at junctions and unions between gypsum plates and cornices.
F. Adhesives: Adhesives shall comply with the relevant practices and standards for this type of work.
G. Suspension System: Metal suspension system shall be designed and installed to suit the ceiling layout. Sizes and spaces of vertical hangers being determined by the location, weight and nature of the element. Hangers will be designed to accommodate the weight of flat bed ceiling along with the weight of fibrous plaster mouldings. The Contractor shall be responsible for ensuring that all sub-framing grounds and fixings are fit for the purpose and enable satisfactory completion of the works.
H. Mechanical Fastenings: All mechanical fastenings to be protected by galvanizing or other approved suitable plating. Proprietary fixings comprising corrosion resistant expanding inserts or threaded studs to work being fixed shall comply with the requirements of CP 290, 1973

2.3 MIX PROPORTIONS
A. The Contractor shall submit his mix design for the Engineer's approval prior to the commencement of any part of this work.
B. Mix proportions for fibrous plaster to be designed to give 50 years life for installed work.
PART 3 – EXECUTION

3.1 GENERAL

Workmanship shall conform to applicable British Standards and Codes of Practice governing this type of work. The components shall be formed using the approved design mix, with all constituent materials being accurately gauged, batched or weighed. Moulds shall be dimensionally and geometrically accurate, release agents/waxes shall be such as to allow the clean release of casting without adversely affecting the component surfaces.

3.2 MOULDS

Moulds and castings shall include all necessary fixing holes, brackets, etc. Castings shall be individually inspected and any surface blemishes rectified. Fibrous plaster mouldings shall be cured for a period of 3 days minimum before transportation to site. Arrises of all mouldings shall be finished with pencil rounded finish.

3.3 TOLERANCES

The components shall be true in shape and free from cup and bow. The dimensional accuracy shall be ± 2mm per metre and the horizontal plane deviation shall not exceed 0.3% of the components length. The squareness of rectangular components shall be such that the difference between the diagonals shall not exceed 0.5% of the shorter diagonal.

3.4 DENSITY

The formed components shall be asbestos free, antistatic and shall have a density not exceeding 1500 kg/m3 and be unaffected by ultra violet light and not support fungoid attack.

3.5 COMBUSTIBILITY

A. Components shall be classed non-combustible when tested to BS 476, Part 4, have a Class 1 spread of flame characteristic to BS 476, Part 7.

B. All unions between gypsum plates and cornices shall be lapped and bonded with Hessian fiber and gypsum to ensure an unbreakable bond.

3.6 SETTING OUT

A. All units shall be set out accurately to give level soffits, etc., free from undulations and lipping, with all lines and joints straight and parallel to the walls, unless specified otherwise. Ensure that light fittings, grilles, etc., are in correct positions and that all trades use common setting-out points.

3.7 JOINTS

A. Jointed sections of curved fibrous plaster shall follow exactly the same profile on each adjoining section and at their meeting edges, unless otherwise specified, and the resulting joints shall be filled and reinforced as necessary, to be invisible and to ensure no shrinkage cracks occur at these positions.

B. Jointed sections of flat fibrous plaster shall be flush across the joints, and in the horizontal plane, unless designed to be otherwise, and the resulting joints shall be filled and reinforced as necessary, to be invisible and to ensure no shrinkage cracks occur at these positions.
C. Joints between fibrous plaster and other materials are to be filled and reinforced as necessary to be invisible and to ensure no shrinkage cracks occur at these positions.

End of Section 09265
## SPECIFICATION SECTION 09300
### TILE WORK

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PART 1 – GENERAL

1.1 SECTION INCLUDES
A. The work under this section consists of furnishing and installing all ceramic / porcelain and quarry tiles and related work as shown on the drawings and as specified herein.
B. Threshold at door opening.

1.2 REFERENCES
B. ANSI A108.3 - Quarry Tile and Paver Tile Installed with Portland Cement Mortar.
C. ANSI A108.4 - Installation of Ceramic Tile with Organic Adhesives or Water Cleanable Tile Setting Epoxy Adhesives.
D. ANSI A108.5 - Installation of Ceramic Tile With Dry-Set Portland Cement Mortar Or Latex Portland Cement Mortar.
E. ANSI A108.9 - Installation of Ceramic tile with Modified Epoxy Mortar/Grout.
F. ANSI A108.10- Installation of Grout in Tilework.
G. ANSI A118.1 - Dry-Set Portland Cement Mortar.
H. ANSI A118.3 - Chemical Resistant, Water Cleanable tile-Setting and Grouting Expand Water Cleanable tile Setting Epoxy Adhesive.
I. ANSI A118.4 - Latex-Portland Cement Mortar.
J. ANSI A118.5 - Chemical Resistant Furan Mortars and Grouts for Tile Installation.
K. ANSI A118.6 - Ceramic Tile Grouts.
L. ANSI A118.8 - Modified Epoxy Emulsion Mortar/Grout.
M. ANSI A136.1 - Organic Adhesives for Installation of Ceramic tile.
N. ANSI A137.1 - Standard Specifications for Ceramic tile.
O. TCA (Tile Council of America) - Handbook for Ceramic Tile Installation.
P. BS 6431 (British Standards)

1.3 SUBMITTALS
A. Shop Drawings : Indicate tile layout perimeter conditions, junctions with dissimilar materials, control and expansion joints, thresholds and setting details.
B. Complete set of samples of manufacturer's standard products for color selection.
C. Product Data: Provide instructions for using adhesives and grouts.
D. Samples: Mount selected tile on two plywood panels, 24 x 24 inch (600mm x 600mm) in size illustrating pattern, color variations, and grout joint size variations and color.
E. Manufacturer's Certificate: Certify that Products meet or exceed specified.
F. Complete set of samples of manufacturer's standard products for color selection.
G. Tile manufacturer's complete installation instructions.

1.4 MOCKUP
A. Provide mockup of tile as directed by owner's representative.
B. Construct mockup with waterproofing, finish grout and specified accessories.
C. Locate where directed.
D. Mockup to include wall and floor tile in adjacent location
E. Mockup may remain as part of the work.

1.5 DELIVERY, STORAGE AND HANDLING
A. Deliver products to site in manufacturer's original containers.
B. Protect adhesives from overheating in accordance with manufacturer's instructions.
C. Products shall be stored in accordance with manufacturer's instructions with labels.

1.6 EXTRA MATERIALS
A. Provide 6 percent of each size, color and surface finish of tile specified in marked cartons.
PART 2 – PRODUCTS

2.1 CERAMIC/PORCELAIN TILE MATERIALS

A. General:
   Tile shall comply with ANSI A137.1.
   1. Tile shall be Standard Grade.
   2. Tile shall be graded and containers grade-sealed in accordance with minimum grade specifications established in ANSI A137.1.

2.2 CERAMIC FLOOR TILE:

A. Floor tiles shall be natural clay, cushion edge, unglazed ceramic, with size indicated on drawings and color as approved by the engineer.
B. Tile shall be back mounted.

2.3 PORCELAIN TILE

A. Provide factory-mounted flat tile, square edge, slip resistant, with abrasive admixture.
B. Tile shall be with size indicated on drawings and color as approved by the engineer.

2.4 QUARRY TILE:

A. Quarry tile shall be seamless, impervious to water square-edged, with size as shown on drawings and of color selected by the Engineer. Cove bases and trims shall be provided.
B. Where required to be slip-resistant, tile shall be manufacturer’s standard abrasive-surfaced tile with paved aluminum oxide or other rust proof aggregate of comparable hardness uniformly impregnated into the face surface of the tile.

2.5 BOND COAT

A. For Walls: Portland cement paste. Dry-set or latex-Portland cement mortar permissible with wall tile. (For dry-set or latex Portland cement mortar on a mortar bed cured for a minimum of 20 hr at 70º F or above follow method W213.) as per TCA W211-84.
B. For Floors: Portland cement paste on a plastic bed or dry-set mortar or latex-Portland cement mortar on a cured bed expansion joints as per TCA F112-84.

2.6 GROUT MATERIALS

A. Grout: ANSI A118.6, tile grout, color as selected.

2.7 ACCESSORIES

A. Waterproofing Membrane:
   1. Waterproofing membrane shall be a one part elastomeric and seamless membrane of at least 30mils (1/32) inch.
B. Thresholds:
   1. Marble color and type to be selected.
   2. 12 mm thick with honed finish by full width of wall or frame opening.

2.8 SELF-LEVELLING UNDERLAYMENT

A. Cement-based topping

B. When mixed according to manufacturer's instructions should become a liquid material which will seek its own level and produce a smooth, flat surface.
3.1 EXAMINATION
A. Verify that surfaces are ready to receive work.

3.2 PREPARATION
A. Protect surrounding work from damage or disfiguration.
B. Vacuum clean surfaces and damp clean.
C. Seal substrate surface cracks with filler. Level existing substrate surfaces to acceptable flatness tolerances.

3.3 INSTALLATION - THINSET METHOD
A. Install adhesive, tile and thresholds in accordance with manufacturer's instructions.
B. Install tile in a modular grid with wall and floor tile joints matching in accordance with BS 6431 Part 1 (En 87)
C. Where required to be sloped floors, they should slope toward any floor drain.
D. Lay tile to pattern indicated. Do not interrupt tile pattern through openings.
E. Place thresholds at locations indicated.
F. Cut and fit tile to penetrations through tile. Form corners and bases neatly. Align floor, base and wall joints.
G. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make joints watertight, without voids, cracks, excess mortar or excess grout.
H. Sound tile after setting. Replace hollow sounding units.
I. Allow tile to set for a minimum of 48 hours prior to grouting.
J. Grout tile joints.

3.4 INSTALLATION - MORTAR BED METHOD
A. Install cement screed / mortar bed, tile, waterproofing membrane and grout in accordance with manufacturer's instructions.
B. Install tile in a modular grid with wall and floor tile joints matching in accordance with BS 6431 Part (En 87).
C. Apply mortar bed to provide slope to drain as indicated in shower areas.
D. Lay tile to pattern indicated. do not interrupt tile pattern through openings.
E. Cut and fit tile tight to penetrations through tile. Form corners and bases neatly. Align floor, base and wall joints.
F. Place tile joints uniform in width, subject to variance in tolerance allowed in tile size. Make joints watertight, without voids, cracks, excess mortar or excess grout.
G. Sound tile after setting. Replace hollow sounding units.
H. Allow tile to set for a minimum of 48 hours prior to grouting.
I. Grout tile joints.
3.5 INSTALLATION QUARRY TILE

A. Thinset Method: As specified in paragraph 3.03.

B. At Depressed Slab Area:
   1. Depressed slab area shall be filled using self-levelling underlayment to required level to receive quarry tile installed by thinset method as specified in paragraph 3.03.

3.6 CLEANING

A. Clean grout and setting materials from face of tile while materials are workable. Leave tile face clean and free of all foreign matter.

B. Remove all grout haze, observing tile manufacturer's printed recommendations as to use of chemical cleaners if permitted by tile manufacturer. Protect metal surfaces and plumbing fixtures from effects.

End of Section 09300
### SPECIFICATION SECTION 09510
### SUSPENDED ACOUSTICAL CEILING

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PART 1 – GENERAL

1.1 SECTION INCLUDES

Grid suspension system for acoustical ceiling.

Mineral fiber acoustical ceiling tiles as shown on the Drawings and as specified in this section.

1.2 REFERENCES

ASTM - American Society for Testing and Materials

<table>
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UL - Underwriters Laboratories, Inc.
UL Fire Resistance Directory

1.3 SUBMITTALS

Samples of grid system components and ceiling tiles.
Certification that the components meet the requirements and tests specified.

1.4 TRANSPORTATION, HANDLING AND STORAGE

Deliver acoustical ceiling units to project site in original, unopened packages and store them in fully enclosed space where they will be protected against damage from humidity, direct sunlight, surface contamination, and other causes. Handle acoustical ceiling units carefully to avoid chipping edges or damaging units in any way.

1.5 WARRANTY

Submit written guarantee signed by the contractor and manufacturer for 2 years from the date of substantial handover. Guarantee shall cover repair and replacement of defective material and workmanship.
1.6 QUALITY ASSURANCE

Engage an experience installer who has successfully completed acoustical ceilings similar in material, design and extent to that indicated for the Project.

1.7 PROJECT CONDITIONS

Do not install acoustical materials unless temperature and humidity conditions closely approximate the interior conditions which will exist when the building is occupied. Maintain temperature and humidity conditions during and after installation. Plastering, concrete and terrazzo work (including grinding) shall be complete dry. Windows and doors shall be in place and glazed.
PART 2 – PRODUCTS

2.1 SUSPENSION SYSTEM

A. General: Ceiling tile manufacturer’s standard suspension system fabricated of cold-rolled hot-dipped galvanized sheet steel components providing minimum 170 g/m$^2$ zinc coating conforming BS 2989 or ASTM A 653. System shall be designed and fabricated to meet the requirements of ASTM C 635 or equivalent BS standards. Finish shall be electro-statically applied powder coated polyester paint, white color or as approved by the Engineer.

B. Hanger Wires: Galvanized steel wires, pre-stretched, not less than 2 mm diameter.

C. Hanger Wire Anchors: Drill-in type as approved by the Engineer.

D. Accessories: Edge Moldings, hold-down clips and other necessary accessories shall be provided in accordance with the Engineer selection and approval.

2.2 ACOUSTICAL CEILING TILE

A. Acoustical ceiling tiles shall be of mineral fiber of modular design and sizes and shall be of size 600 x 600 x 19 mm thick, unless otherwise indicated on the drawings. Tiles shall be fit the pattern as shown on the drawings. Mineral fiber tiles conforming to BS 476, Class O/Class 1 or ASTM E 1264 or Federal Specifications FS-SS-S-118B, Type III, form 1 units; Class A; STC Range of 34-40 dB; NRC from 0.50 to 0.70; density of 240-260 kg/m$^3$; RH of 90%; Flame Spread of 0-25 and Smoke Developed 0-50 in accordance with ASTM E 84 or equivalent standards.

B. Finish: Factory-applied washable white finish or as shown in drawings and approved by the Engineer, with light reflectance value of LR over 75 percent.

C. Access Hatches: Provide manufacturer standard access hatches which are designed specially for the acoustical ceiling systems. Provide the access hatches with complete features including door locks, frames, pivots, metal trims and gaskets.
PART 3 – EXECUTION

3.1 INSTALLATION
A. The installation of all acoustical ceiling work covered in this section shall be done by a qualified subcontractor for acoustical ceiling systems work recommended by the manufacturer, having at least 5 years experience in successfully completed projects.

3.2 SUSPENSION SYSTEM
A. Installation of suspension system shall be in accordance with BS 8290 or ASTM C 636 and in accordance with manufacturer's directions.
B. Rough Suspension:
   1. Space hanger wires at 1200 mm on centers, each direction. Supported from structural angle runners by looping and wire-tying.
   2. Hangers shall be installed at ends of each suspension member and at light fixtures, 150 mm from vertical surfaces.
   3. Wires shall not be splayed more than 125 mm in a 1200 mm vertical drop.
   4. Wire shall be wrapped a minimum of three times horizontally, turning the ends upward.
C. System shall be level within tolerance specified and parallel with walls.
D. Wall moldings shall be installed at intersection of suspended ceiling an vertical surfaces.
   1. Corners shall be mitered where wall moldings intersect or corner caps shall be installed in lieu thereof.
   2. Continuous ribbon of acoustical adhesive or caulking compound shall be applied on vertical web.
   3. Attachment to vertical surface shall be by means of mechanical fasteners.

3.3 CEILING TILES
A. Installation of acoustical ceilings shall not begin until the building has been closed to weather with Relative Humidity not more than 70 percent.
B. Ceiling tiles shall be in a levelled plane and in straight line courses.
C. Provide cutting and patching for the passage of materials of other trades.

3.4 CLEANING
A. Clean exposed surfaces of acoustical ceiling including trims, edges, moldings and suspension members. Comply with manufacturer's instructions for cleaning and touch-up of minor finish damage. Remove and replace work which cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

End of Section 09510
SPECIFICATION SECTION 09626

DECORATIVE LAMINATE FLOORING - COMMERCIAL LAMINATE (12MM)

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PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Armstrong Commercial Laminate Flooring
B. Floating foam underlayment
C. Maintenance products
D. Coordinated transitions and moulding pieces
E. Adhesives

1.2 RELATED SECTIONS

A. Other Division 9 sections for floor finishes related to this section but not the work of this section.
B. Division 3 Concrete; not the work of this section.
C. Division 6 Wood and Plastics; not the work of this section.
D. Division 7 Thermal and Moisture Protection; not the work of this section.

1.3 REFERENCES

B. ASTM E 662 (Smoke Generation) Maximum Specific Optical Density
E. ASTM F 970 (Standard & Modified) Test Method for Static Load Limit.
F. ASTM F 710 - Standard Practice for Preparing Concrete Floors.
G. ASTM F 1869 - Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

1.4 QUALITY ASSURANCE AND REGULATORY REQUIREMENTS

A. Select an installer who is competent in the installation of Armstrong Commercial Laminate flooring or has a minimum of 5 years experience handling similar products.
B. If required, provide types of laminate flooring and accessories supplied by one manufacturer, including leveling and patching compounds, and adhesives.
C. If required, provide flooring material to meet the following fire test performance criteria as tested by a recognized independent testing laboratory:
   1. ASTM E 648 Critical Radiant Flux of 0.45 watts per sq. cm. or greater, Class I.
   2. ASTM E 662 (Smoke Generation) Maximum Specific Optical Density of 450 or less.
1.5 SUBMITTALS

A. Submit product data in accordance with Section (01 30 00) (01 33 00), including manufacturer's installation and maintenance instructions.

B. Submit shop drawings/floor layout, transition/moulding details, and manufacturer's technical data, installation and maintenance instructions for flooring and accessories.

C. Submit the manufacturer's standard samples showing the selected design visual for flooring and all applicable accessories.

D. If required, submit the manufacturer's certification that the flooring has been tested by an independent laboratory and complies with the required fire tests.

1.6 ENVIRONMENTAL CONDITIONS

A. Deliver materials in good condition to the jobsite in the manufacturer's original unopened containers that bear the name and brand of the manufacturer, project identification, and shipping and handling instructions. Cartons of laminate should be delivered the day of installation and do not require acclimation. However, in extreme cases where laminate has been stored incorrectly or in unfavorable conditions it is highly recommended to acclimate to proper installation conditions.

B. Store materials indoor in a clean, dry, enclosed/conditioned space off the ground, and protected from the weather and from extremes of heat and cold. Protect adhesives from freezing. Protect flooring from exposure to moisture along with moisture producing sources resulting from wet trades such as and not limited to drywall, concrete, masonry, painting, and grouting work. If a temporary heating source is utilized at the jobsite be cognizant that this practice can result in adding environmental moisture which may affect laminate products. All trade work shall be complete and cured prior to shipment delivery.

C. Maintain a minimum temperature in the spaces to receive the flooring and accessories of 65ºF (18ºC) and a maximum temperature of 100ºF (38ºC) for at least 48 hours before, during, and for 48 hours after installation. Protect all materials from the direct flow of heat from hot-air registers, radiators, or other heating fixtures and appliances. Preferred jobsite Relative Humidity shall be between 35% - 55%, not to exceed limits for optimum product performance. Ensure that permanent HVAC is in operation (minimum 14 days) along with permanent lighting prior to installation. Keep in mind that adverse fluctuations in Relative Humidity for extended periods of time may result in expansion and contraction of laminate flooring leading to complaints and possible floor failure.

D. Install flooring and accessories after all other finishing operations and construction have been completed. Close spaces to traffic during the installation of the flooring and protect flooring surface as necessary with a breathable material after the completion of installation. Do not install flooring over concrete slabs or wood substrates until they are sufficiently dry to achieve a bond with the adhesive (especially when employing direct glue down method to substrate), in accordance with the manufacturer's recommended bond and moisture tests.
2.1 COMMERCIAL LAMINATE FLOORING MATERIALS

A. Provide Commercial Laminate (Direct Pressure Laminate) consisting of four layered construction, installed by Lock & Fold system, in 4.92 in. width x 47.24 in. length (125mm x 1200mm) with Micro Edge / Micro Ends having a nominal total gauge of 0.47 in. (12 mm). A four layered thermal fused process includes a smooth, AC5 abrasion resistant wear surface composed of cellulose paper saturated with melamine resin embedded with Aluminum Oxide to provide stain and scratch resistance, a High Definition/ Masterworks Technology with VTX print saturated with melamine resin to provide fade resistance, a High Density Fiberboard core with Hydra Core Plus technology for added moisture resistance, and a melamine saturated balanced backing paper for added dimensional stability. Flooring shall meet composition, size, thickness, and all specifications listed on product cartons.

2.2 TRANSITION AND MOULDING PIECES

A. Provide all available coordinating transitions and moulding pieces designated for %ITEM% to meet installation application for finishing and transitioning to other flooring products. Install in accordance with manufacturer's guidelines and intended use.

2.3 ADHESIVES

A. Provide adhesive for optional glue application on Floating installations. Use of adhesive to seal and glue Laminate joints is not required in Commercial applications but recommended for areas that are likely subjected to topical moisture sources, as a preventative measure. See limitations to installation in high moisture areas in product literature. Provide Wood Flooring Adhesive for optional Glue Down application directly to substrate. Follow installation instructions on adhesive label for Glue Down applications. Understand that Laminate by design is intended as a floating application with the introduction of a Locking mechanism and seldom requires the use of glue. However, if requested can be fully glued provided that the manufacturer's substrate requirements are met. It should be advised that a Glue Down application will add additional installation time, clean up, material cost, and may hinder the ease of installation with a Locking Laminate. Depending on which installation method is employed all recommendations shall be followed in accordance with the manufacturer’s instructions.
PART 3 – EXECUTION

3.1 INSPECTION

A. Examine subfloors prior to installation to determine that surfaces are smooth and free from cracks, holes, ridges, and other defects that might prevent adhesive bond or impair durability or appearance of the flooring material.

B. Inspect subfloors prior to installation to determine that surfaces are free from curing, sealing, parting and hardening compounds; residual adhesives; adhesive removers; oil, grease, wax; and other foreign materials that might prevent adhesive bond. Visually inspect for evidence of moisture, alkaline salts, carbonation, laitance, mold, or mildew.

C. Report conditions contrary to contract requirements that would prevent a proper installation. Do not proceed with the installation until unsatisfactory conditions have been corrected.

D. Failure to call attention to defects or imperfections will be construed as acceptance and approval of the subfloor. Installation indicates acceptance of substrates with regard to conditions existing at the time of installation.

3.2 PREPARATION

Suitable Substrates:
Include existing in place marble, stone, ceramic, terrazzo, vinyl sheet/tile, and over subfloors with radiant heating systems, not to exceed 85ºF (29ºC). See latest edition of F-5061 for proper floor preparation prior to installation.

3.3 INSTALLATION OF COMMERCIAL LAMINATE FLOORING

A. Install flooring in strict accordance with the manufacturer Installation System", F-5061.

B. Install flooring wall to wall before the installation of floor-set cabinets, casework, furniture, equipment, movable partitions, etc. Extend flooring into toe spaces, door recesses, closets, and similar openings as shown on the drawings.

C. If required, install flooring on pan-type floor access covers. Maintain continuity of color and pattern within pieces of flooring installed on these covers. Adhere flooring to the subfloor around covers and to covers.

D. Scribe, cut, and fit to permanent fixtures, columns, walls, partitions, pipes, outlets, and built-in furniture and cabinets leaving the required expansion of 1/4 inch to 1/2 inch.

E. Install flooring with adhesives, tools, and procedures in strict accordance with the manufacturer's written instructions. Observe the recommended adhesive trowel notching, open times, and working times.

3.4 INSTALLATION OF ACCESSORIES

A. Install all coordinated transitions and moulding pieces in accordance with manufacturer's installation system", F-5061.

B. Fill small voids and complete minor repairs with acrylic filler.
3.5 CLEANING AND PROTECTION

A. Perform initial maintenance according to the latest edition of manufacturer’s installation system, F-5061 under the care instructions with the proper cleaners.

B. When utilizing direct Glue down method protect floor from heavy traffic for a period of 24 hours to allow for the adhesive to cure properly and 72 hours for rolling loads. If access is needed immediately after installation use underlayment panels over top of the flooring to prevent flooring shift and to distribute weight evenly. Conversely, if a Floating application is utilized then traffic is permitted immediately with care to prevent topical damage.

C. Protect installed flooring as recommended by the flooring manufacturer against damage from rolling loads, other trades, or the placement of fixtures and furnishings.

End of Section 09626
SPECIFICATION SECTION 09900
PAINTING

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PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Painting materials complete with primers, sealers, stains applied for exterior and interior areas as indicated on Drawings and as specified in this section.

1.2 SUBMITTALS

A. Product Data: Submit manufacturers technical information including instructions for thinning, mixing, curing and touch-up.

B. Manufacturer's standard color charts.

C. Test Reports and certificates of compliance.

D. Samples: Prior to beginning work, furnish color chips for surfaces to be painted. Submit samples for the Engineer's review of color and texture only. Provide a listing of material and application for each coat of each finish sample.
   1. 300 mm x 300 mm hardboard, provide 2 samples of each color and material, with texture to simulate actual conditions. Re-submit samples as requested by the Engineer until acceptable sheen, color and texture is achieved.
   2. Wood surfaces, provide 2 samples 100 x 200 mm of natural and stained wood finish on actual wood types. Label and identify each as to location and application.
   3. Concrete masonry, provide two 100 mm square samples of masonry for each type of finish and color, defining filler, prime and finish coat.
   4. Actual wall surfaces and other exterior and interior building components, duplicate painted finishes of prepared samples. Provide full-coat finish samples on at least 9 m² of surface, as direct, until required sheen, color and texture is obtained; simulate finished lighting conditions for review of in-place work.
   5. Final acceptance of colors will be from samples applied on the job.

1.3 TRANSPORTATION, HANDLING AND STORAGE

A. Deliver materials to job site in manufacturer's original new and unopened packages and containers bearing manufacturer's name and label, and following information:
   1. Name or title of material.
   2. Manufacturer's stock number and date of manufacture.
   3. Manufacturer's name.
   4. Contents by volume, for major pigment and vehicle constituents.
   5. Thinning instructions.
   6. Application instructions.
   7. Color name and number.

B. Store materials not in actual use in tightly covered containers in a well-ventilated area and protect from moisture, direct sunlight and temperatures below 10oC and above limits recommended by the manufacturer. Maintain containers used in storage of paint in clean conditions, free of foreign materials and residue.

C. Keep storage area neat and orderly. Remove oily rags and waste daily. Take all precautions to ensure that workmen and work areas are adequately protected from fire hazards and health hazards resulting from handling, mixing and application of paints.
1.4 QUALITY ASSURANCE

A. Single Source Responsibility: Provide primers and other undercoat paint produced by same manufacturer as finish coats. Use only thinners approved by paint manufacturer, and use only within recommended limits.

B. Coordination of Work: Review other Sections of these Specifications in which prime paints are to be provided to ensure compatibility of total coatings system for various substrates. Upon request from other trades, furnish information or characteristics of finish materials provided for use, to ensure compatible prime coats are used.

C. Material Quality: Provide manufacturer's best quality trade sale paint material of various coating types specified. Paint material containers not displaying manufacturer's product identification will not be acceptable.

1.5 JOB CONDITIONS

A. Do not paint when air is dust-laden or when weather and temperature conditions are unsuitable. Do not paint exterior surfaces in damp or rainy weather. Comply with manufacturer's recommendations with respect to application and drying period temperatures.

B. Apply water-based paints only when temperature of surfaces to be painted and surrounding air temperatures are between 10°C and 32°C, unless otherwise permitted by paint manufacturer's printed instructions.

C. Apply solvent-thinned paints only when temperature of surfaces to be painted and surrounding air temperatures are between 7°C and 35°C, unless otherwise permitted by paint manufacturer's printed instructions.

D. Do not apply paint when relative humidity exceeds 85% or to damp or wet surfaces; unless otherwise permitted by paint manufacturer's printed instructions.

1.6 EXTRA MATERIALS

A. Provide extra stock 10 barrels for every color.
PART 2 – PRODUCTS

2.1 MATERIALS

A. Material Quality: Paints, coatings, and primers shall be readymixed at the manufacturer's plant and shall be delivered in sealed containers, labelled and identified. Provide best quality grade of various types of coatings as regularly manufactured by acceptable paint materials manufacturers. Paints and finishes shall have Class A rating in accordance with ASTM E 84. Materials without manufacturer’s identification as a standard, best-grade product will not be acceptable. Use products of same manufacturer for succeeding coats.

B. Color Pigments: Pure, non-fading, applicable types to suit substrates and service indicated.

C. Color and Texture:
   1. Exterior Painting: Color and texture of the exterior paint shall be as indicated on Drawings and as approved by the Engineer.
   2. Interior Painting: Colors, textures, and degree of luster will be as indicated on Interior Design Drawings and Interior Design Specifications. Color selection will include safety colors for hazards in accordance with ANSI Z53.1 Safety Color Code for Marking Physical Hazards. Tint prime and undercoats approximately to the shade of the final coat but with sufficient variation to distinguish them from the preceding coat.

D. Mildewcide: Paints shall contain a mildewcide as recommended by the manufacturer.

E. Solvents and Thinners: As recommended by the paint manufacturer.

2.2 PAINTING SCHEDULE

A. Interior Paint Schedule:
   1. Concrete, Plaster, Gypsum Board, Reinforced Decorative Gypsum and Masonry:
      a. Prime Coat: Acrylic Solvent Based Primer, flat.
      b. Second Coat: Acrylic Emulsion, Dry Film Thickness 25 micron (DFT).
      c. Finish Coat: Same as for second coat.
   2. Epoxy paint on cement screed floors and block and plaster walls:
      a. Prime Coat: As per epoxy paint manufacture recommendation.
      b. Second Coat: Two components polyamide cured epoxy paint with silica non-skid additive, Dry Film thickness 100 micron (DFT).
      c. Finish Coat: Same as for second coat.
   3. Ferrous Metals:
      b. Second Coat: Alkyd Enamel, semi-gloss, 30 micron (DFT).
      c. Finish Coat: Same as for second coat.
   4. Zinc-Coated Metals:
      a. Same as specified for Exterior Paint Schedule.
   5. Painted and Natural Finish Wood:
      a. Same as specified for Exterior Paint Schedule.
   6. Exposed Pipes, Ducts, and Metal work:
      b. Second Coat: Alkyd Enamel, semi-gloss, 30 micron (DFT).
      c. Finish Coat: Same as for second coat.
PART 3 – EXECUTION

3.1 INSPECTION

Examine substrate and conditions under which painting will be performed. Proceed with the work only when conditions are satisfactory.

Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions otherwise detrimental to formation of a durable paint film.

3.2 SURFACE PREPARATION

A. General:

1. Remove hardware and accessories, machined surfaces, plates, lighting fixtures, and similar items in place and not to be finish-painted, or provide surface-applied protection prior to surface preparation and painting operations. Remove, if necessary, for complete painting of items and adjacent surfaces. Following completion of painting of each space or area, reinstall removed items.

2. Clean surfaces to be painted before applying paint or surface treatments. Remove oil and grease prior to mechanical cleaning. Program cleaning and painting so that contaminants from cleaning process will not fall onto wet, newly-painted surfaces.

3. Perform preparation and cleaning procedures in accordance with paint manufacturer's instructions and as specified in this section, for each particular substrate condition.

4. Fill dents, cracks, hollow places, open joints, and other irregularities with filler suitable for the purpose and, after setting sand to a smooth finish.

5. Prime surfaces not more than 8 hours after cleaning. Provide barrier coats over incompatible primers or remove and re-prime as required. Notify the Engineer in writing of any anticipated problems in using the specified coating systems with substrates primed by others.

B. Concrete, Masonry and Plaster Works: Prepare surfaces of concrete, concrete masonry cement plaster and gypsum plaster to be painted by removing efflorescence, chalk, dust, dirt, grease, oils, and by roughening as required to remove glaze. Use abrasive blast-cleaning methods if recommended by paint manufacturer and approved by the Engineer.

1. Determine alkalinity and moisture content of surfaces to be painted by performing appropriate tests. If surfaces are found to be sufficiently alkaline to cause blistering and burning of finish paint, correct this condition before application of paint. Do not paint over surfaces where moisture content exceeds that permitted in manufacturer's printed directions.

2. Clean concrete floor surfaces scheduled to be painted with a commercial solution of muriatic acid, or other etching cleaner. Flush floor with clean water to neutralize acid, and allow to dry before painting.

C. Gypsum Board: Repair minor cracks and holes with finishing compound, and sand smooth after drying.

D. Wood: Clean wood surfaces to be painted of dirt, oil, or other foreign substances with scrapers, mineral spirits and sandpaper, as required. Sandpaper smooth those finished surfaces exposed to view, and dust off. Scrape and clean small, dry, seasoned knots and apply a thin coat of white shellac or other recommended know sealer, before application of priming coat. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood-filler. Sandpaper smooth when dried.
E. Ferrous Metals: Clean non-galvanized ferrous-metal surfaces that have not been shop coated; remove mortar, plaster, grease, dirt, rust, loose mill scale and other foreign substances by solvent or mechanical cleaning methods that comply with the recommendations of the Steel Structures Painting Council, before priming coat is applied.

F. Shop-Primed Ferrous Surfaces: Remove grease, oil and other foreign substances with approved type of cleaner manufactured for the purpose. Exercise care to prevent damage to shop coat. Touch-up abraded or marred shop coats with paint used for priming.

G. Zinc-Coated (Galvanized) Surfaces: Remove grease and oil with a cleaner manufactured for the purpose. Treat surfaces with a chemical compound such as a phosphoric acid wash. Remove the chemical compound completely with clean, fresh water.

3.3 MATERIALS PREPARATION

A. Mix and prepare painting materials in accordance with manufacturer's directions.

B. Maintain containers used in mixing and application of paint in clean condition, free of foreign materials and residue.

C. Stir materials before application to produce mixture of uniform density, stir as required during application. Do not stir surface film into material. Remove film and, if necessary, strain material before using.

3.4 APPLICATION

A. Apply paint in accordance with the manufacturer's directions. Use applicators and techniques best suited for the type of material being applied. Do not exceed manufacturers recommended coverage per gallon. Apply materials with care to a uniform and proper film thickness, showing no runs, holidays, sags, crawls, or other defects. Apply with a minimum of brush marks. Finish surfaces shall be uniform in sheen, color and texture and match approved samples.

B. Allow coats to dry thoroughly before succeeding coats are applied; allow a minimum of 24 hours between applications on any one surface unless otherwise specified by the paint materials manufacturer.

C. Sandpaper undercoats on interior metal thoroughly and uniformly to provide a smooth, even surface for finish coats.

D. Apply paint by brush, roller, spray, or other acceptable practice in accordance with the manufacturer's directions. Use brushes best suited for the type of material being applied. Use rollers of carpet, velvet back, or high-pile sheep wool as recommended by the paint manufacturer for material and texture required.

E. Brush-out and work all brush coats into the surfaces in an even film. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, or other surface imperfections will not be acceptable. Neatly draw all primer or first coats, unless otherwise permitted to use mechanical applicators.

F. Except as otherwise specified, apply a prime coat to material which is required to be painted or finished.

G. Apply the first-coat material to surfaces that have been cleaned, pre-treated or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
H. Number of coats and paint film thickness required is the same regardless of the application method. Sand between each enamel and varnish coat application with fine sandpaper or rub surfaces with pumice stone where required to produce an even, smooth surface in accordance with the paint manufacturer's directions.

I. Allow sufficient time between successive coatings to permit thorough drying. Do not re-coat until paint does not deform or feel sticky under moderate thumb pressure and the application of loss of adhesion of the undercoat.

J. Paint type, color, surface treatment shall be as scheduled. Provide finish coats which are compatible with prime paints used.

K. When undercoats, stains, or other conditions show through the final coat of paint, apply additional coats until the paint film is of uniform finish, color and appearance. Insure that all surfaces including edges, corners, crevices, welds, and exposed fasteners receive a film thickness equivalent to that of flat surfaces.

L. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Paint surfaces behind permanently-fixed equipment or furniture with prime coat only. Exposed surfaces are defined as those areas visible when permanent or built-in fixtures, convector covers, covers for finned tube radiation, grilles and similar items are in place in areas scheduled to be painted.

M. Where visible through registers or grilles, paint interior surfaces of ducts and void spaces with a flat, non-specular black paint.

N. Paint the back sides of access panels and removable or hinged covers to match the exposed surfaces.

O. Finish exterior doors on tops, bottoms and side edges the same as the exterior faces, unless otherwise indicated.

P. Omit primer on metal surfaces that have been shop-primed and touch-up painted.

Q. Dry Film Thickness: Provide dry film thickness for each finish type, including prime and finish coats, not less than total dry film thickness as specified in painting schedule.

R. Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling such as laps, irregularity in texture, skid marks, or other surfaces imperfections.

S. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, or other surface imperfections will not be acceptable.

T. Transparent (Clear) Finishes: Use multiple coats to produce glass-smooth surface film of even luster. Provide a finish free of laps, cloudiness, color irregularity, runs, brush marks, orange peel, nail holes, or other surface imperfections. Provide satin finish for final coats, unless otherwise indicated.

U. Completed Work: Match approved samples for color, texture and coverage. Remove, refinish or re-paint work not in compliance with specified requirements.

3.5 CLEAN-UP AND PROTECTION

A. Clean-Up:
   1. During progress of work, remove from site discarded paint materials, rubbish, cans and rags at end of each work day.
2. Upon completion of painting work, clean window glass and other paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch otherwise damage finished surfaces.

B. Protection:
1. Protect work of other trades, whether to be painted or not, against damage by painting and finishing work. Correct any damage by cleaning, repairing or replacing, and re-painting, as acceptable by the Engineer.
2. Provide Wet Paint signs as required to protect newly-painted finishes. Remove temporary protective wrappings provided by others for protection of their work, after completion of painting operations.
3. At completion of work of other trades, touch-up and restore damaged and/or defaced surfaces.

End of Section 09900
SPECIFICATION SECTION 09901
PAINTING OF MECHANICAL AND ELECTRICAL WORK

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PART 1 – GENERAL

1.1 DESCRIPTION
A. Definitions:
1. "Paint" and "painting" refer to all applied coatings.
2. Finished room or space: One that has finish called for on Interior Room Finish Schedule
B. Work included: Paint all:
1. Other mechanical and electrical items not completely factory finished.
2. Exposed ductwork, piping, insulated piping, conduit, busways and raceways in finished rooms and spaces.
C. DO NOT PAINT:
1. Anodized aluminum, chromium plate, brass, bronze, stainless steel face plates, glass.
2. Moving parts of operating units.
3. Code labels, equipment identification and rating plates.

1.2 QUALITY ASSURANCE
A. Fire ratings required in exit routes: NFPA 101.
B. Flame spread testing: ASTM E84.
C. Colours: the colour, texture and gloss of respective products specified in this section shall match the appearance shown in the color schedule and colour palette.

1.3 SUBMITTAL (SEE SECTION 01300)
A. Product data:
Manufacturer's data showing conformance to specifications, for all products.
B. Samples: Prepare samples of each paint system specified on 600 x 600 mm (24 x 24 IN) hardboard or gypsum board for approval, and if necessary re-submit samples until colours and gloss are satisfactory.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING
A. Deliver in original containers, factory-mixed, except for tinting of undercoats and possible thinning in unopened containers, each labelled as follows:
1. Name or type number of material.
2. Manufacturer's name and stock number and colour.
3. Contents by volume, of major constituents.
4. Instructions for thinning.
5. Application instructions.
6. Date of production and date of expire.
B. Protect materials from damage.
C. Store materials in places designated by the Client's or Architect. Client's. Keep storage neat and clean. Repair damage thereto or to surroundings. Remove rags and waste from building daily. Avoid danger of fire.
1.5 JOB CONDITIONS

A. Perform no work unless temperature in building is maintained at constant 18 degC or above. Assure that adequate ventilation exists for escape of moisture.

B. Avoid wide temperature variations.

C. Maintain a rough schedule showing when painter expects to complete respective coats of paint for various areas. Keep schedule current as job progress dictates.
PART 2 – PRODUCTS

2.1 MATERIALS GENERAL

A. Paints: As specified in paragraphs (Interior Paint Systems).
   1. Use best quality by approved manufacturers.
   2. Paints without NFPA 101, Class A or B ratings may not be used in exit routes.
   3. Undercoats shall be produced by the same manufacturer as finish coats.
   4. Exterior paint shall be non-chalking and mildew resistant.

B. Unspecified products: Use best quality by reputable, recognized manufacturers.

C. Color: As noted in Architect’s color schedule, and indicated in Section 15060, Paragraph "Pipe Identification”.

D. Reference standards: Provide paint material with listed Federal Specification reference which conforms to or surpasses the performance characteristics of material manufactured to the chemical composition required by the standard. In case of conflict between the referenced standard and the descriptive specification, the descriptive project specification shall govern.

2.2 PAINT MATERIALS

A. Rust inhibiting alkyd primer, eggshell:
   2. Solids by weight: 60 percent.
   3. Dry film thickness: 0.032 mm (1.25 mil).
   4. Characteristics: F.S. TT P 664C or TT-P-636D; lead free or lead limited; fast-drying for exterior or interior.

B. Zinc chromate primer:
   2. Dry film thickness: 51 microns (2.0 mil).
   4. Quality: F.S. TT P 645A or TT-P-1757 (3).

C. Galvanized metal latex primer, flat:
   1. Solids by volume: 40 percent.
   2. Solids by weight: 54 percent.
   3. Dry film thickness: 33 microns (1.3 mil).
   4. Characteristics: MIL P 28577A. or TT-P-001975. Fast drying exterior primer for unpainted galvanized metal, requiring no chemical pre-treatment, lead free of lead limited.

D. Alkyd interior trim primer, flat:
   2. Solids by weight: 71 percent.
   3. Dry film thickness: 31 microns (1.25 mil).
E. Latex interior wall primer, flat:
   1. Solids by volume: 30 percent.
   2. Solids by weight: 43 to 45 percent.
   3. Dry film thickness: 30 microns (1.2 mil).

F. Alkyd enamel undercoated, dull:
   2. Solids by weight: 68 percent.
   3. Dry film thickness: 31 microns (1.25 mil).

G. Alkyd interior enamel, low sheen (eggshell):
   1. Solids by volume: 51 to 48 percent.
   2. Solids by weight: 74 to 68 percent.
   3. Dry film thickness: 44 to 31 microns (1.75 to 1.25 mil).

H. Alkyd exterior or interior enamel, gloss:
   2. Solids by weight: 58 to 62 percent.
   3. Dry film thickness: 31 microns (1.25 mil).

2.3 SUPPLEMENTARY MATERIALS

A. Filler, crack and seam (for wood, metal concrete or mortar) .........................F.S.TT-F-322
B. Turpentine (Distilled) .........................................................................................F.S. TT-T-801C.
C. Mineral spirits ........................................................................................................F.S. TT-T-291E.
D. Linseed oil, boiled .................................................................................................F.S. TT-L-190C.
E. Linseed oil, heat polymerized ...............................................................................F.S. TT-L-201.

2.4 PAINT SYSTEMS - GENERAL

A. Following is a listing of surfaces and type of paint to be applied to each.
B. All "low sheen" finish coats shall have a gloss rating of 10 to 15 at 60 deg angle per ASTM D3134. Submit gloss samples for approval prior to use. Add flatteners if necessary to achieve specified gloss.

2.5 INTERIOR PAINT SYSTEMS

A. Pipe and duct insulation:
   1. 1 coat Latex wall primer, flat.
   2. 1 coats Alkyd Enamel, Undercoated.
   3. 1 coat Alkyd Enamel, Low Sheen.
B. Metals in finished areas:
   1. 1 coat Alkyd Interior Trim Primer, Flat, recommended by manufacturer.
   2. 1 coat Alkyd Enamel, Undercoated.
   3. 1 coat Alkyd Enamel, Low Sheen.

C. All other metals:
   1. 1 coat Alkyd Interior Trim Primer, Flat, recommended by manufacturer.
   2. 2 coats Alkyd Enamel, Gloss.
PART 3 – EXECUTION

3.1 INSPECTION
A. Examine surfaces carefully for defects which cannot be corrected and might prevent satisfactory results.
B. Commencing of work in a specific area constitutes acceptance of surfaces, and responsibility for satisfactory work.

3.2 PREPARATION GENERAL
A. Assure that surfaces are clean and dry.
B. Assure that surfaces are free of foreign materials which will affect adhesion or appearance.
C. Remove mildew and neutralize surface.
D. Eliminate efflorescence before painting.
E. Before painting, test surfaces with moisture meter. Do not paint until moisture is within paint manufacturers acceptable limits.

3.3 PREPARATION FERROUS METAL SURFACES AND HOLLOW METAL
A. Follow requirements of SSPC SP 1 and SP 3.
B. Wire brush, or grind as necessary to remove shoulders at edge of sound paint to prevent telegraphing.
C. Touch up damaged shop coats. For surfaces with touched up shop coat, omit first coat.

3.4 PREPARATION GALVANIZED METAL SURFACES AND NON ANODIZED ALUMINIUM
A. Follow requirements of SSPC SP 1; Passivate.

3.5 APPLICATION GENERAL
A. Paint surfaces as specified in Paragraphs "Paint Systems".
B. Provide complete coverage and hide.
   1. All paint systems are "to cover".
   2. When colour or undercoats show through, apply additional coats until paint film is of uniform finish and colour, at no additional cost.
C. Employ only skilled mechanics.
D. Mix and apply as recommended by manufacturer.
E. Use undercoats produced by the same manufacturer as finish coat.
F. Do not apply succeeding coats until the Client's representative has an opportunity to observe previous coat.
G. Remove and protect hardware, accessories, plates, fixtures, finished work, and similar items; provide ample in-place protection for items that cannot be readily removed. Upon completion of painting, carefully replace all removed items and/or remove protection.
H. Apply all materials under adequate illumination. Evenly spread and flow paint smoothly on for full, smooth cover, free of runs, sags, thin areas, and other defects.

I. Assure that coats are dry before recoating.

J. Touch up abraded areas of shop prime coats before applying subsequent coats.

3.6 PROTECTION AND CLEANUP

A. Protect adjacent work against damage by painting and finishing work. Clean, repair or replace, and repaint damaged work or provide new acceptable work as directed by the Architect.

B. Provide Wet Paint signs as required while work in progress.

C. Remove temporary protective wrappings, provided by other trades for protection of their work, after completion of painting operations. Clean all paint spattered surfaces. Take care not to damage finished surfaces.

D. Remove any surplus materials, scaffolding and debris. Leave areas broom clean.

End of Section 09901
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# SPECIFICATION SECTION 10100
## MARKER BOARDS AND TACK BOARDS

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PART 1 – GENERAL

1.1 DESCRIPTION

A. GENERAL:

1. Furnish all labour, materials, tools, equipment, and services for chalkboards and tack boards, in accord with provisions of Contract Documents.
2. Completely co-ordinate with work of other trades.
3. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.
4. Unless otherwise approved, furnish all chalkboards and tack boards by one manufacturer.

1.2 SUBMITTAL

A. SAMPLES:

200 x 250 mm samples of sheet materials.

1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver boards completely assembled whenever possible. Where dimensions exceed available panel size, provide 2 or more pieces of length acceptable to the client. When dimensions require delivery in separate units, pre-fit at factory, disassemble for delivery, and make final joint at site.

B. Perform all required unpacking at site.
PART 2 – PRODUCTS

2.1 MATERIALS

A. MARKERBOARDS, METAL:
   Balanced, high-pressure laminated, 3-ply construction, with facing sheet, core, and backing sheet.
   1. Finish:
      Porcelain enamel surface coat minimum 0.076 mm thick fused to ground coat on writing surface with seal coat on reverse side of steel sheet. Comply with the Porcelain Enamel Institute Specifications S-104.
   2. Face sheet:
      Enamelling steel, minimum 0.6 mm.
   3. Core:
      6 mm thick plywood or hardboard, unless otherwise indicated.
   4. Backing sheet:
      0.4 mm zinc-plated steel, or 0.3 mm random porcelain coil, or 0.3 mm aluminum sheet.
   5. Lengths:
      One piece up to 4800 mm for hardboard core; to 2400 mm for plywood core.
   6. Backing panel:
      Moisture resistant plywood or hardboard 6 mm thick, with 6 mm backing; or, core may be one piece 12.5 mm thick.

B. TACKBOARDS, PLASTIC IMPREGNATED CORK:
   Seamless sheet, 6 mm thick with washable vinyl finish, of ground natural cork compressed with integral color throughout, laminated to burlap backing.

C. FRAMES AND TRIM:
   Minimum 1.5 mm thick extruded aluminum, ASTM B221, alloy 6063-T5.
   1. Size and shape as indicated.
   2. Single-length units to minimize joints.
   3. Miter all corners to a neat, hairline closure.
   5. Manufacturer's standard "narrow" trim, approximately 12 mm wide.
   6. When structural support accessories are required for chalkboards in addition to normal trim, provide such additional support or modify trim as required to provide necessary support.
   7. Snap-on trim, with no visible screws or exposed points.

D. CHALK TROUGHS:
   Continuous for each markerboard. Box type, extruded aluminum with slanted front and matching cast aluminum end closures.

2.2 COMPONENTS

A. MARKERBOARD TYPE: MB-1
   1. Materials:
      a. Porcelain enamel surface on steel.
b. Continuous chalk trough.

2. Dimensions:
   a. Width : 2400 mm
   b. Height : 1200 mm

B. MARKERBOARD TYPE: MB-1B

1. Materials:
   a. Porcelain enamel surface on steel.
   b. Continuous chalk trough.

2. Dimensions:
   a. Width : 2000 mm
   b. Height : 1200 mm

C. MARKERBOARD TYPE: MB-2

1. Materials:
   a. Porcelain enamel surface on steel.
   b. Continuous chalk trough.

2. Dimensions:
   a. Width : 1500 mm
   b. Height : 1200 mm
PART 3 – EXECUTION

3.1 INSPECTION

A. Examine substrate and conditions under which work is to be performed.
B. Correct unsatisfactory conditions.
C. Installation constitutes acceptance of responsibility for performance.

3.2 INSTALLATION

A. Unless otherwise indicated, provide factory-built units.
B. Provide trim at joints between marker board and tack boards.
   Treat vertical joints in marker board as follows:
C. Steel board units: Use extended aluminium H-type divider bars.
D. Provide additional backing as indicated or necessary to properly stiffen and support boards.
E. Install at locations and heights indicated in accordance with manufacturer’s instructions.
F. Install with concealed hangers, plumb and level.
G. Co-ordinate job-assembled units with grounds, trim, and accessories. Join all parts with neat, precision fit.
H. In addition to requirements of these specifications, comply with manufacturer’s instructions and recommendations.

End of Section 10100
# SPECIFICATION SECTION 10270

## ACCESS FLOORING SYSTEM

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PART 1 – GENERAL

1.1 DESCRIPTION

A. General
1. Furnish all labor, materials, tools, equipment, and services for raised flooring in accordance with provisions of Contract Documents.
2. Completely coordinate with work of all other trades.
3. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.
4. See Division 1, for General Requirements.

B. Related work specified elsewhere:
1. Section 08310, Access doors & panels.

1.2 SYSTEM DESCRIPTION

A. The raised access floor system shall consist of completely removable accessible and interchangeable floor panels, surfaced with rubber finish and supported by an adjustable pedestal assembly and interconnecting steel stringer channels. The entire assembly is to rest on previously prepared existing concrete subfloor.

B. Load: Floor system shall be capable of supporting a uniform live load of 1220 Kg/m² with a maximum deflection of 1 mm and a concentrated load of 454 Kg/6.5 cm² with a maximum deflection of 2.15 mm on a rolling caster at any point. Permanent set shall not exceed 0.15 mm. Ultimate strength shall have a safety factor of 4.

C. The finished floor top surface shall be level within + or - 2.5 mm over its longest span and within + or - 1.6 mm over any 3000 mm.

D. Corrosion Protection: All components of the floor system shall receive the manufacturer’s standard corrosion-resistant coating.

E. Grounding: The entire raised floor system below the floor covering line shall be electrically grounded so as to guarantee continuity for grounding all panels of the floor system. There shall be no ungrounded exposed metal on upper floor surface.

F. Pedestals: Maximum axial load of 2200 Kg, without permanent deformation.

G. Lateral Stability: In all directions with or without panels in place.

H. Surface electrical resistance not to exceed one ohm per panel.

I. Flame spread Classification: Class 1 surface in accordance with B.S. 476 fire retardation designation F30 and ASTM E-84-81A CLASS A.

1.3 SUBMITTAL

A. Shop drawings:
1. Submit shop drawings in accordance with Sec. 01340 of specifications.
2. Indicate flooring layout, any interruptions to grid, details of assembly perimeter and conditions.

B. Product data:
Submit manufacturer’s product data sheets which upon the approval of the Engineer, be substituted in part for the shop drawings.

C. Test reports:
Submit certification that all components are in accordance with the specifications and test reports from an independent testing laboratory of the loading and other required performances of the system.

1.4 QUALITY ASSURANCE
A. The work of this section shall only be performed by a firm of installers who can give evidence of the satisfactory installation of computer floors in other projects over the last 3 years.
B. Installation to be supervised by an authorized representative of the manufacturer.

1.5 PROTECTION
A. Protect the work of others from damage as result of the work of this section.
B. Protect the work of this section from any damage by others until its completion.

1.6 COORDINATION
A. Coordination with others, in particular the Electrical Work and the Suppliers of Equipment to rooms in which the access floors are installed to ensure that all cable cutouts, etc., are properly installed in the correct locations.

1.7 EXTRA STOCK
A. Provide 15% additional of each type 610x610 mm removable panels with an antistatic high pressure laminate finish.
PART 2 – PRODUCTS

2.1 MATERIALS

A. Panels shall be of laminated construction with wood particle core completely encased in steel with internal ground and finished on exposed surface with level loop pile, with static-dissipative qualities and urethane unitary backing, passing NBS Aminco Smoke Chamber test (450 or less) and with 1.0 KV or less static generation as tested under AATC-134-1979. Panel size 610x610 mm. Air flow panels with 25% open space.

B. Pedestals shall consist of a minimum 19 mm threaded steel rod welded to a galvanized steel base plate with an adjustable pedestal head. Pedestal head shall have a conductive sound dampening pad at the top to receive the bearing portion of the panel and shall be designed to bear on the special steel leveling nut on the threaded rod. Pedestal head assembly shall permit 75 mm total vertical adjustment at any time without the use of tools. A positive locking device shall engage the pedestal head and leveling nut, preventing disengagement of floor leveling through vibratory action.

C. Cutouts with vinyl or non conductive cutout moulding and sponge rubber air seals as required.
3.1 EXAMINATION
   A. Examine all conditions to which the work of this section is attached both at the time of bidding (drawings) and at the time of installation. Ensure that all conditions are suitable to provide a complete and satisfactory installation. Report any deficiencies to the Engineer.

3.2 INSTALLATION
   A. Layout computer access floor to layout indicated on the drawings.
   B. Install in accordance with manufacturer's written instructions, a copy of which shall be on site at time of installation.
   C. Height as indicated on drawings.
   D. Perform cutout work to layout plan provided at a later date.

3.3 CLEAN-UP
   A. Promptly, as the work proceeds, clean up and remove from the site any surplus materials and rubbish resulting from the work of this section.
   B. After erection, sweep floor clean and touch up scratches, defects or minor blemishes.

End of Section 10270
SPECIFICATION SECTION 10440

SIGNS

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PART 1 – GENERAL

1.1 DESCRIPTION

A. General:
1. Furnish all labor, materials, tools, equipment, and services for all signs as indicated, in accordance with provisions of the Contract Documents.
2. Completely co-ordinate with work of all other trades.
3. Although such work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

B. Read in conjunction with signage:
1. Drawing number SG series signage layout & types.
2. Signage schedules (A4 size documents).

1.2 QUALITY ASSURANCE

A. Fabricators and Installers:
Companies specializing in performing the work of this Section shall have a minimum of five (5) years documented experience in the production and installation of commercial signs.

B. Uniformity of Manufacturer:
Furnish products of a single manufacturer.

1.3 SUBMITTAL

A. Shop drawings:
1. General:
Provide shop drawings of signs for review and approval of the Client. Shop drawings shall include sign location plans, sign message schedule, and complete details and specifications of sign fabrication and installation.
2. Exterior Signage: (Name and emblem of the building)
Submit shop drawings for fabrication and erection of specially signs, includes elevations and large scale details of sign wording, lettering layout and emblem. Show anchorages and accessory items furnish location template drawings for items supported or anchored to permanent construction.

B. Product Data:
Required for the Client review.

C. Samples:
1. Color and font for approval.
2. Submit one complete sign unit of interior sign type "T" showing finishes, colors, surface textures and qualities of manufacture and design of each component including graphic images. Accepted samples may be used as part of the installed work.
3. Submit one letter complete with its anchorage for the exterior sign showing finishes, surface textures and qualities of manufacture.
D. Contract Close Out Information:
   Recommended cleaning procedures.

1.4 INTENT OF DRAWINGS

A. Sign locations shown on the furniture and signs location plans are approximate and are intended to show the general locations and orientations of each sign scheduled, and are not intended to be rigid in detail. The locations of signs shall be confirmed by the Client prior to installation.

B. Comply with typical mounting elevations shown for sign mounting heights and position standards.

C. Field verify all sign locations, mounting surface dimensions and conditions prior to installation of signs. Report any discrepancies to the Client.

D. Sign Message Layouts:
   Sign layouts shown are presented to establish graphic standards of copy size, interline spacing, margin spacing and overall position of graphic images and may not show the entire magnitude of the work. Where actual sign copy layouts are not shown, conform with the requirements established for that sign type. Sign messages for all signs shall be approved by the Client prior to fabrication.
PART 2 – PRODUCTS

2.1 MATERIALS

A. Acrylic Polyurethane:
   Catalyst acrylic polyurethane formulated paint for background and edge colors, which are recommended by aluminum and acrylic producers or finisher for optimum adherence to aluminum and acrylic surfaces, and are non-fading for applications indicated, consisting of a prime and a finish coat.

B. Acrylic sheet:
   Cast (not extruded or continuous cast) clear acrylic plastic sheet with a minimum flexural strength of 110,400 KPa, ASTM D 790, minimum allowable continuous service temperature of 82°C, in size and thickness indicated.

C. Adhesives:
   Silicone adhesive as recommended by aluminum and acrylic producers for permanent adherence to indicated interior surfaces.

D. Aluminum:
   Alloy and temper recommended by aluminum producer or finisher for type of use and finish indicated and with not less than the strength and durability properties specified in ASTM B209 for 5005-H15. Minimum thickness shall be as shown.

E. Anchors And Inserts:
   Non-ferrous metal or hot-dipped galvanized anchors and inserts as required for corrosion resistance. Furnish inserts, as required, for concrete, masonry or gypsum board installation surfaces.

F. Bronze Sheet:
   Bronze sheet plate, recommended by finisher for exterior application shown.

G. Bronze Casting:
   Provide bronze castings, coppery alloy UNS C83600, complying with the requirements of ASTM B584.

H. Fasteners: Unless otherwise indicated, use concealed fasteners fabricated from metals that non-corrosive to either the sign materials or the mounting surface.

I. Fibre Board:
   1. Medium density:
      19 mm thick.
   2. Finish:
      Matte for painting.
   3. Color:
      Noted as "Green" on drawings; match Pentane Matching System No. 3282C; formula 6 parts Pentane Green, 2 parts Pentane Process Blue, and 0.5 part Pentane Black.
   4. Finish all surfaces.

J. Foam Tape:
   Double-faced pressure sensitive foam tape with a minimum width of 25 mm suitable for interior applications.
K. Magnetic Tape:
   Composite vinyl and barium ferrite run on magnetic poles, running through sheeting. Poles run parallel to edge of sheet, specific gravity of 3.8.

L. Porcelain Enamel:
   PEI S-100, Class A, acid-resistant porcelain enamel finish.

M. Silk-screening Enamel:
   Colored silk screening inks or paints, which are recommended by stainless steel or acrylic producer or finisher for optimum adherence to stainless steel and acrylic surfaces and are non-fading and scratch-resistant for applications indicated.

N. Vinyl Film:
   Opaque, ultraviolet light resistant, non-discoloring, non-reflective vinyl film, 0.09 mm minimum thickness, with pressure sensitive adhesive backing, suitable for interior and exterior applications.

O. Stainless Steel:
   Sheet as recommended by stainless steel producer or finisher for type of use and finish indicated and with not less than strength and durability properties specified in ASTM, A484 and A276, type 302 or type 304.
   Color: Manufacturer's standard "White".

2.2 FABRICATION

A. General:
   Produce smooth, even, level sign panel surfaces, constructed to remain flat under installed conditions. Provide signs with edges mechanically and smoothly finished. Cut characters from anodized aluminum sheet using computer controlled laser cutting equipment; hand cut characters are not acceptable. Mechanically grind all edges to produce characters with sharp edges.

B. Sign Type C:
   Cut panels from aluminum or bronze sheet in the sizes and thickness shown.

C. Sign Type N2:
   Cut sign back plate and clear matte face plate from acrylic in the sizes shown. Form a message insert panel pocket by laminating acrylic strips on three sides between the back plate and face plate. Rout thumb impressions into the sign panel access edge of the back plate to allow for removal of message inserts. Cut message insert panels from PVC sheet.

D. Sign Types:
   1. Sign panel, types I,K,L and R:
      Cut sign back plate and clear matte face plate from acrylic in the sizes shown. Form a message insert panel pocket by laminating acrylic strips on three sides between the back plate and face plate, and between image areas as shown. Rout thumb impressions into the sign panel access edge of the back plate to allow for removal of message inserts. Cut message insert panels from PVC sheet.
   2. Sign panel, type E,F,M,S and T:
      Cut sign back plate and clear matte face plate from acrylic in the sizes shown. Do not laminate until graphic images are applied as specified.
   3. Sign panels, types D:
      Cut sign back plate and clear matte acrylic face plate from acrylic in the sizes shown. For all
sign panels, form a message insert panel pocket by laminating acrylic strips on top and bottom of panel between the back plate and face plate, and between image areas as shown. Rout thumb impressions into the sign panel back plate to allow for removal of message inserts. Do not laminate back plate and face plate until graphic image process is performed as specified, framing trims are gold aluminum.

E. Sign Frames:
Fabricate sign frames from aluminum sheet. Drill mounting holes in back of frame prior to finishing. Fabricate frame in accordance with porcelain enamel specifications.

2.3 FINISHES

A. Colors And Surface Textures:
Provide color and finish matches as indicated, or if not indicated, as selected by the Client from manufacturer's standards.

B. Porcelain Enamel:
Apply porcelain enamel coating on all surfaces of sign frames, with a minimum coating thickness of 0.2 mm.

C. Colors:
All sign backgrounds:
Noted as "Green" on drawings; match Pantone Matching System No. 3282C; formula 6 parts Pantone Green, 2 parts Pantone Process Blue, and 0.5 part Pantone Black.
PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine the area and conditions under which signs are to be installed.
B. Do not install signs on unfinished architectural surfaces.
C. Do not proceed with the work until unsatisfactory conditions have been corrected.
D. Protect surrounding materials and surfaces from defacement and damage.
E. Beginning of installation means installer accepts existing conditions.

3.2 INSTALLATION

A. General:
   1. Locate sign units and accessories where shown and scheduled, using mounting methods of type described and in compliance with manufacturers' instructions, unless otherwise indicated.
   2. Install sign units level, plumb and at height indicated, with sign surfaces free from distortion or other defects of appearance.

B. Wall Mounting Signs:
   1. Unframed signs:
      Install unframed wall mounted signs with double-faced neoprene tape and silicone adhesive.
   2. Framed signs:
      Drill holes in wall surface for acceptance of mounting screws. Use inserts in all wall surfaces. Install sign frame to wall surface. Install sign panels to sign frames with magnetic tape.

C. Overhead Signs:
   1. Install overhead signs utilizing hardware shown. Paint all exposed hardware to match sign background color. Anchor to structural elements where required.
   2. Wherever practicable, do not permit fastenings or installation materials to be exposed to view after installation is complete.

3.3 CLEANING AND PROTECTION

1. At completion of installation, clean soiled sign surfaces in accordance with manufacturer's instructions. Protect units from damage until acceptance by the Client.
2. Remove protection for surrounding materials and surfaces after final cleaning.
3. Instruct the Client on the proper cleaning of all sign units, and submit written documentation of recommended cleaning procedures to the Client.

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PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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:
This Section includes high-density mobile storage units with carriage-mounted storage units.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Provide mobile storage units capable of withstanding the effects of earthquake motions determined according to the building codes.
B. Design Requirements: Total height of all mobile storage systems shall not be greater than 96”. All shelving elevations per attached schedule.

1.4 SUBMITTALS (UPON AWARD OF CONTRACT)

A. Product Data: Include installed weight, load criteria, furnished specialties, and accessories. Product Data: Submit manufacturer’s product literature and installation instructions for each type of shelving, track and installation accessory required. Include data substantiating that products to be furnished comply with requirements of the contract documents.
B. Shop Drawings: Prepared by or detailing fabrication, assembly, and installation of mobile storage unit, as well as procedures and diagrams. Include details of layout and installation including clearances, spacing, and relation to adjacent construction in plan, elevation, and section; clear exit and access aisle widths; access to concealed components; components, assemblies, connections, attachments, reinforcement, and anchorage; and deck details, edge conditions, and finish flooring. Submit shop drawings showing location, ranges and extent of high density storage shelving system. Show installation details at non-standard conditions. Furnish floor layouts, technical and installation manuals for every unit shipment with necessary dimensions for rail layout and system configuration at the project site.

1. Provide layout, dimensions, and identification of each unit corresponding to sequence of installation and erection procedures. Specifically include the following:
   a. Location, position and configuration of tracks on all floors.
   b. Plan layouts of positions of carriages, including all required clearances.
   c. Details of welded frame shelving, indicating method and configuration of installation in carriages.

2. Provide location and details of anchorage devices to be embedded in or fastened together construction. Furnish templates if required for accurate placement.
3. Include schedule and erection procedure for proper installation.

C. Samples: Of each exposed product and for each color and texture required, at least 3 inches square in size. Selection Samples: For initial selection of colors and textures, submit manufacturer’s color charts consisting of actual product pieces, showing full range of colors and textures available.

D. Installer Certificates: Signed by manufacturer certifying that installers comply with specified
requirements. Submit manufacturer’s certification that products comply with requirements of the contract documents.

E. Warranty: Submit a written warranty, executed by Contractor, Installer, and Manufacturer, agreeing to repair or replace units which fall in materials or workmanship within the specified warranty period. This warranty shall be in addition to and not a limitation of other rights the Owner may have against the Contractor under Contract Documents.

1. The entire movable compact shelving installation will be warranted against defects in material for 10 years and workmanship for a period of five years from date of acceptance by the Owner.

F. Maintenance Data: For mobile storage units submit material suitable for inclusion in manuals. Include operating and maintenance instructions, parts inventory listing, purchase source listing, emergency instructions, and similar information. Submit manufacturer’s instructions for proper maintenance materials and procedures. Submit manufacturer’s printed instructions for maintenance of installed work, including methods and frequency recommended for maintaining optimum condition under anticipated use conditions include precautions against materials and methods which may be detrimental to finishes and performance.

G. Reference List: Provide a list of recently installed mobile storage units to be visited by owner, architect, and construction manager. Visit is intended to witness operation and quality of installation. Manufacturer is required to address all issues raised by Owner, Architect, and Construction Manager with written responses. Issues unresolved by manufacturer may result in termination of manufacturer at no cost or repercussion to the Owner, Architect, and Construction Manager.

1.5 QUALITY ASSURANCE (SUBMITTALS DUE TO ALL BIDDING CONTRACTORS AT TIME OF BID, FAILURE TO DO SO WILL BE CAUSE FOR DISQUALIFICATION)

A. Installer Qualifications: Engage an experienced installer who is an authorized representative of the mobile storage unit manufacturer for both installing carriages and anchoring shelving units to carriages required for this Project with not less than 10 years experience installing systems similar to those required for this project, and licensed or certified by mobile storage system manufacturer. Certification required by manufacturer on manufacturer’s letterhead at time of bid. Certifications by sales reps, dealers or distributors are unacceptable. Guaranteed minimum response time to service call of 24 hours required, and must be part of submittal.

B. Manufacturers Certification: Separate written certifications by manufacturer on manufacturers letterhead at time of bid required stating compliance with all specifications of both the mobile and shelving systems. Shelving certification must confirm compliance with all actual shelf sizes as noted in these specifications. If bidding different manufacturers for mobile and shelving, two certifications are required.

1.6 PROJECT CONDITIONS

A. Field Measurements: Verify mobile storage unit location by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating mobile storage units without field measurements. Coordinate construction to ensure actual dimensions correspond to established dimensions.

B. Delivery, Storage, & Handling: Comply with instructions and recommendations of manufacturer for special delivery, storage and handling requirements.
C. Sequence & Scheduling: Sequence storage shelving system installation with other work to minimize possibility of damage and soiling during remainder of construction period.

D. Pre-installation Conference: Conduct conference at Project site to comply with requirements of Division 1 Section “Project Meetings”. Review methods and procedures related to mobile storage units including, but not limited to, the following:
1. Inspect and discuss condition and levelness of flooring and other preparatory work performed under other contracts.
2. Review structural loading limitations.
3. In addition to the Contractor and the installer, arrange for attendance of the following:
   d. Other installers affected by the work of this section.
   e. The Owner's Representative.
   f. The Architect.
   g. Manufacturer's representative.
PART 2 – PRODUCTS

2.1 MATERIALS

A. BASIS OF DESIGN: Products are based upon Power Assist Movable Shelving System. Provide products complying with requirements of the contract documents and made:
  1. Space saver Corporation

B. GROUT
  1. General: The compound shall be a hydraulic type cement which, when mixed with water, will harden rapidly to produce a permanent bolt setting anchor. The compound shall conform to the following specifications, all of which are based on the performance of the test specimens at room temperature and in laboratory air.
  2. Linear Movement: It shall not shrink on setting, but shall exhibit a slight expansion of not more than 0.002 inches per linear inch.
  3. Compression Strength: Two inch cubes made in accordance with ASTM standards tested on a Balding-Southward machine of 60,000 pounds capacity shall have the following minimum average compression strengths:
     Age:  1 hour ---- 4,500 psi
           7 days ---- 8,000 psi
  4. All tracks must be grouted the entire length of each run, including all rail joints.

C. TRACK
  1. Rails shall be designed and manufactured to carry loads of 1,000# per lineal foot of carriage. Minimum 1035 steel, minimum rail assembly dimensions of 3/4” high x 1 1/8” wide. Rail contact surface shall be minimum 5/8” wide.
  2. Rails shall be level with and not project above or below the walking surface. Rails to be designed to recess in concrete slab block outs. All concrete work by others. Manufacturer to provide form cover at rail for protection during back pour of concrete. All floor covering by others.
  3. Rails shall be designed to be attached on top of structural concrete floor and to allow for adjustment so rails can be leveled over an uneven floor.
  4. Maximum profile of recess adjacent to rail to accommodate manufacturer’s carriage guidance system and/or anti-tip system 1-1/8” wide by 3/4” deep.
  5. All rail connection joints shall be designed to provide horizontal and vertical continuity between rail sections, to gradually transfer the concentrated wheel point load to and from adjoining rail sections. Butt joints unacceptable.
  6. Rail shall be located and positioned properly, leveled and grouted, allowing at least 1/4” for grout under high point. Grout to be worked under rail, any voids completely filled and trimmed up sides flush with rails. This will allow proper weight distribution from rail to subfloor. (Shims unacceptable.)
  7. Levelness of rails: 3/32” maximum variation from true level within any module; 1/16” maximum variation between adjacent rails, perpendicular to rail direction; 1/32” maximum variation in 10’0” of rail length, along any rail.
  8. Rails to be rechecked for integrity of position and levelness and anchored into structural concrete slab, using anchors in sizes and quantities as determined by manufacturer.
9. Main rail section shall be a minimum of 6’ each with shorter sections used only to terminate each individual rail assembly.

D. FLOOR / RAMP (Alternate Add, base bid is concrete by General Contractor)
   1. Finished elevation of the raised floor shall be flush with the top of the rails.
   2. The ramp shall not extend beyond the end of the carriages and shall have a maximum slope of nine degrees. The vertical transition from the ramp edge to the floor shall be a maximum of 1/8". Ramps shall extend under all movable and stationary ranges. Provide ramp at both ends of mobile system.
   3. Floor panels shall be constructed of a minimum 3/4" thick, 5-ply underlayment grade plywood. Particle board unacceptable.
   4. The floor and ramp shall be constructed in a manner that will absolutely prevent any warping or deformation of the floor panels in a normal operating environment. Panels must be supported a minimum of 16" on center in both directions to assure structural walking surface.
   5. Floor covering is to be installed and supplied by the Owner.
   6. All floor / ramps shall be APA fire retardant grade.

E. CARRIAGES
   1. All carriages are to be welded or bolted steel construction. Galvanized structural components and/or riveted carriages are unacceptable. Carriages and stationary platforms shall be constructed of minimum 12-gauge steel.
   2. Fixed carriages, as shown on the drawing, shall be of same construction and height as the movable carriages and anchored to rails. Setting of shelving on floor at ends of mobile runs is unacceptable.
   3. Necessary carriage splices shall be bolted type designed to maintain proper unit alignment and weight load distribution.
   4. Carriage straightness shall have no more than 1/4" maximum deviation from a true straight line. There shall be no permanent set or slippage in any spliced or welded joint when exposed to forces encountered in normal operating circumstances.
   5. Carriage construction shall be so designed to allow the shelving uprights to recess and interlock into the carriages a minimum of 3/4". The shelving units will be secured to the carriage frames with vibration proof anchors. (Top mount shelving is unacceptable.)
   6. Each carriage shall have two wheels per rail.
   7. Carriages shall be powder coat paint finished (1.5 mil.) inside and out. Color selection by Owner to match shelving. Powder coat paint finish is required for finish durability and elimination of any off gassing. Finish has to be inert, with no volatiles present in finished product Galvanized steel structural carriage components are unacceptable.

F. DRIVE / GUIDE SYSTEM
   1. Drive/guide system shall absolutely prevent carriage whipping, binding and wheel/rail wear under normal operation. All connections between drive shafts shall be by means of secured coupler connections. Drive shaft shall exhibit no play or looseness over the entire length of that assembly. All rotating load bearing members must ride in ball or roller bearings. All line shaft bearings shall be a pillow block or flange self-aligning type. Line shaft shall be minimum ¼” solid steel or 1 ¼” tubular steel. If line shafts are used, all wheels on one side of carriage shall drive. If synchronized drives are used, a minimum of one wheel assembly driving both sides of carriage at center location required.
G. WHEELS
1. Wheels shall be constructed of solid 1045 steel for smooth operation. Minimum load capacity per wheel 3200 lbs. Wheels shall be precision ground, balanced and hardened. All bearings shall be permanently shielded and lubricated.
2. All drive wheels shall be minimum 5’ diameter (outside dimension).
3. Guide shall be dual flange at all wheel locations, or center flange at three locations.

H. FACE PANELS
All exposed face panels, as shown on drawings, shall be laminate. End panels shall be full depth and height of shelving units.

I. SYSTEM OPERATION
1. Electric Assist: (Optional add to base bid)
   There shall be one directional carriage control handle for each moveable carriage located 44” (1118 mm) from the base of and centered on the face panel. The control shall have, at minimum, a RESET/STOP push-button and a backlit red reset light. The directional control handle on any moveable carriage adjacent to the desired aisle location is moved in the direction away from the desired aisle location to open the system at the desired aisle. That aisle shall then open automatically regardless of the position of the carriages. The carriage control head will display a flashing red reset light at the newly opened aisle indicating that the aisle is locked open and requires resetting before another aisle can be opened. All controls and indicator lights shall be solid state and shall provide visual indication of safety system operation. Each aisle shall have an adjustable limit switch to provide proper timing for start/stop operation. System controls shall start motors sequentially to minimize power demands and shall brake motors to rest dynamically to provide smooth operation. Each carriage to be equipped with a 90 volt D.C. current limited, fractional horsepower gear motor. Gear motor shall be connected to a drive wheel assembly(s) with a #40 roller chain. Controls shall provide sequential movement with a controlled running speed of 3” (76 mm) per second. System shall operate on 115 V.A.C. 50/60 hertz, 10 amp dedicated circuit provided by others, one per module. Overhead mount power pantograph distribution system shall conceal all interconnecting wiring. One safety sweep shall be provided in each aisle. Manual reset controls with 15-second automatic lock out feature are mandatory. Provide minimum of two rechargeable power packs.

J. SAFETY CONTROLS and OPERATION REQUIREMENTS:
Entire system shall be U.L. system listed. Provide certification with bid (mandatory).

K. SHELVING (For A4 size files and box files)
1. 4-Post type (case, clip-type, industrial “X” braced type and cantilever not acceptable) wedge lock design.
   a. Closed end upright construction, full 24-gauge closure panels welded full depth and height of uprights. Intermediate “T” uprights shall be open.
   b. All shelves and canopy tops shall be constructed of minimum 22 gauge.
   c. Shelving material:
      (1) Minimum gauge shelves: 22
      (2) Minimum gauge upright posts: 18
   d. Shelf Type: Standard plain, without slots, ¾” max. profile.
   e. Color: As selected by Architect from manufacturer’s standards (min. 20 colors).
2. All shelving shall be adjustable. No back stops on shelves. Canopy tops required on all sections.
3. All shelves shall be adjustable on 1 ½” centers along the entire height of upright.
   a. 24” deep double face
   b. Clear openings 14.25”
   c. 5 openings @ 15” on center (76 ¼” high uprights – box storage)
   d. A4 size hanging files same as above but must hang from shelf supports on uprights. Vendor to supply _ number of hanging files in addition to the shelving.
4. Shelf supports shall be the entire length of shelf for total support of front and rear edge of shelf. Shall be constructed of minimum 14 gauge for 36” supports and 11 gauge for 44” shelf supports. Maximum deflection under load; must maintain L/140 based on a uniform distributed load of 50 lbs. per lineal foot. Shelf supports shall be ¾” maximum profile.
5. Shelf reinforcements, see attached schedule.
6. All shelving components shall be powder coat paint finished, mandatory, for inert finish.

2.2 EXAMINATION
A. Examine subfloor surfaces, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of mobile storage units.
1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of mobile storage units.
2. Proceed with installation only after unsatisfactory conditions have been corrected.
3. Inspect substrates and conditions in which high density storage shelving, tracks and block outs will be installed and verify that installation may commence. Verify locations of positioning of exits and aisles and overall dimensions of space. Do not proceed with the work until unsatisfactory conditions have been resolved fully.

2.3 INSTALLATION
A. Fully grout tracks. (Supervise back pour of concrete)
B. Permanently attach shelving units to carriages. Stabilize shelving units to comply with mobile storage unit manufacturer’s written requirements. Reinforce shelving units to withstand the stress of movement where required and specified.
C. Install mobile storage systems, shelving, track, blockouts, and accessories after finishing operations, including painting have been completed. Install system to comply with final layout drawings, in strict compliance with manufacturer’s printed instructions. Position units level, plumb; at proper location relative to adjoining units and related work.
D. Field Quality Control: Remove and replace components which are shipped, scratched, or otherwise damaged and which do not match adjoining work. Provide new matching units, installed as specified and in manner to eliminate evidence of replacement.
E. Adjust: Adjust components and accessories to provide smoothly operating, visually acceptable installation.
F. Cleaning: Immediately upon completion of installation, clear components and surfaces. Remove surplus materials, rubbish and debris resulting from installation upon completion of work and leave areas of installation in neat, clean condition.
G. Protection: Protect system against damage during remainder of construction period. Advise Owner of additional protection needed to ensure that system will be without damage or deterioration at time of substantial completion.
2.4 INSTALLATION TOLERANCES

Install tracks parallel and level within 3/32 inch for each length; 1/16 inch between adjacent tracks perpendicular to track direction; and 1/32 inch in 10 feet of track length.

2.5 DEMONSTRATION / CUSTOMER TRAINING

End of Section 10670
# MEP Works Specifications

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FIRE PROTECTION SPECIALITIES

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1.1 APPROVALS
   A. No items shall be installed in breach of any of the existing local Fire Department regulations. In all access, however, installation shall comply with National Fire Codes (NFPA latest editions).

1.2 REQUIREMENTS
   A. Supply and install wherever shown on the drawings all materials specified as per the capacities and ratings indicated on the drawings.

1.3 CODES AND STANDARDS
   A. Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance/manufacturing standards of items mentioned in this section shall confirm to the applicable portions of the latest editions of the following codes, standards and regulations.

1. UL (Underwriters Laboratories Inc)
2. NFPA (National Fire Protection)
3. LPC (Loss Prevention Council)
2.1 PORTABLE FIRE EXTINGUISHERS

A. Extinguisher shall be from ISO 9001, LPCB certified manufacturer rechargeable multipurpose ABC dry chemical type CO2 type as shown on drawings.

B. Each dry chemical unit cylinder shall be coated internally by electrostatic PVC risen, suction tube of Aluminium. It shall be complete with a frame for hanging, to the wall, 36 cm. long hose, discharge valve and pressure gauge. Extinguishers shall be tested to BS 5423.

C. CO2 extinguishers shall be seamless extruded of high grade steel light construction to BS 5423 and to have a rating of 55B. Extinguishers shall have permanent leak proof shut-off safety disc, non metallic horn, flexible hose and wall hooks.

D. Foam type extinguisher shall be mild steel CRI quality. The extinguisher shall be multipurpose foam. It shall be constructed to BS 5423 Standard, with flexible hose and wall hooks.
3.1 MAINTENANCE SCHEDULES

A. Maintenance schedules shall be provided with each type of extinguisher. The schedules shall be in protective covers and shall detail all aspects of maintenance of extinguishers including details of weight checks, pressure test, discharge tests, internal and external visual checks, time periods for checks and action to be taken on finding a fault. The schedules will also contain full details for repairing, recharging and resetting extinguisher contents and re-ordering instructions.

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SPECIFICATION SECTION 21 05 00
COMMON WORK RESULTS FOR FIRE SUPPRESSION

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PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

A. The work of this Division 21 shall be governed by general conditions of contract and sections of Division – 21 and generally the following documents:
   1. Conditions of Contract
   2. Instructions to Tenderers
   3. Form of Agreement
   4. General and Special Conditions of Contract
   5. Form of Tender
   6. Appendices
   7. Applicable Divisions

B. It is the Contractors responsibility to be fully aware of and comply with all of the requirements of the above listed documents, and further assure that all Subcontractors (if any) are equally informed.

1.2 APPLICATION

This section applies to and is part of all Sections of Division 21.

1.3 SCOPE OF WORKS

A. The works covered under this contract include the supply, installation, testing, adjusting and putting into operation systems, components of systems, and individual items of equipment, and work related thereto, in accordance with the project Tender Documents. Products not mentioned but obviously necessary for the completion of those Works shall be provided.

B. Any NFPA or Civil Defense requirement or approval shall be the Contractor responsibility and shall be included in the Tender price and any future requirement either shown on the drawings or specifications shall be done without any additional cost implication to original contract.

C. All Fire Fighting work shall be carried out by Specialist approved by Civil Defense and it is the Contractor responsibility to obtain Civil Defense drawings before the work commence.

D. Piping shall be pitched to permit complete draining of the system.

E. Fire standpipe shall not be used in any way to provide water for other purposes.

F. All valves shall be readily accessible and risers shall be securely supported at each floor.

G. All valves shall be located where readily accessible.

H. All local alarms shall be linked with the electrical fire control panel whenever shown on drawings and or specified in such a way that whenever any local alarm is initiated, a
corresponding pilot and alarm shall be actuated on the main fire control panel to indicate occurrence of fire in the particular zone.

1.4 QUALITY ASSURANCE

The manufacturers of all materials and equipment must have at least ten years of experience in the design and manufacture of their products.

1.5 RELATED WORKS SPECIFIED

A. 21 05 16 - Expansion Fittings and Loop for Fire Suppression Piping
B. 21 05 23 - General Duty Valves for Fire Suppression Piping
C. 21 05 29 - Hangers and Supports for Fire Suppression Piping
D. 21 05 53 - Identification for Fire Suppression System

1.6 APPROVALS

A. No item shall be installed in breach of any of the existing local fire department regulations. In all cases, however, installation shall comply with National Fire Codes (NFPA Latest Edition).

1.7 ENGINEER’S DRAWINGS

A. The Drawings are based on design and include general layouts and typical details of various systems to be installed. The Contractor shall make the installations in a workmanlike manner to conform to the structure, to avoid obstructions, to preserve head room, and to keep openings and passage ways clear without additional instruction and without additional cost to the owner.

1.8 SHOP DRAWINGS AND DATA TO BE SUBMITTED FOR APPROVAL

A. The Contractor shall submit Shop Drawings showing the exact routing and locations of all the piping, ducting, equipment, etc., all in their respective locations and according to the dimensions of the approved manufacturer. Shop Drawings scale shall be 1/10, 1/20, 1/50 and 1/100 as applicable and as approved by the Engineer.
B. The Contractor shall submit catalog cuts and brochures of products with reference to proper paragraph in specifications. All submittals shall be bended in one Booklet.
C. The Contractor shall submit at the beginning of the project a schedule of submittals for materials and shop drawings to the approval of the Engineer.

1.9 APPROVED MATERIALS

A. All materials shall be furnished in accordance with the requirements of the Specifications.
B. The naming of manufacturers in the Specifications shall be strictly adhered to in all circumstances.
C. Substitution of materials other than those named shall not be submitted.
D. Materials shall be delivered in unbroken packages bearing the brand and maker’s name, and shall be stored on platforms and properly covered to protect them from moisture, heat and dust.
E. All materials shall be supplied from the main factories in the country of origin of the
manufacturer. Any deviation from this, like supplying equipment assembled in another different country under a license or another name is not accepted unless approved by the Engineer.

1.10 ABBREVIATIONS

A. The following abbreviations have been mentioned in the specifications.

AGA American Gas Association.
AMCA Air Moving and Conditioning Associations.
ANSI American National Standard Institute.
ARI Air Conditioning and Refrigeration Institute.
ASHRAE American Society of Heating Refrigeration and Air Conditioning Engineers.
ASME American Society of Mechanical Engineers.
AWWA American Water Work Association.
LPC Loss Prevention Council.
BSI British Standards Institution.
SMACNA Sheet Metal and Air Conditioning Contractors National Association.
UL Under Writers Laboratories.
BTU British Thermal Units.
NPC National Plumbing Code.

1.11 WORKMANSHIP

A. All workmanship required to accomplish the work mentioned in Mechanical specification or shown on related Drawings, shall conform to the highest standards, and as required by the Engineer.

B. The Engineer will be the sole judge of the standards required.
2.1 CLEANING AND ADJUSTING

A. All apparatus shall be thoroughly cleaned before being placed in operation. Finished surfaces shall be restored if damaged and entire installation shall be delivered in perfect condition, subject to the approval of the Engineer.

2.2 TESTS

A. All piping and equipment shall be tested as specified under the corresponding section of the Specifications and to meet local and specified requirements. Labor, materials, power, etc., required for testing, shall be furnished by the Contractor, unless otherwise indicated.

B. Tests shall be performed in the presence of representatives of the Engineer and such other parties that have legal jurisdiction and all results shall be recorded.

C. In general, pressure tests shall be applied to piping systems only before connection of fixtures, equipment and appliances. In no case shall any piping, fixtures, equipment or appliances be subjected to pressures exceeding the ratings as prescribed by the manufacturers of fixtures, equipment and appliances, or accepted engineering standards for piping and fittings.

D. All defective work shall be promptly repaired or replaced and the tests shall be repeated until the particular system and component parts thereof receive the approval of the Engineer and authorities having jurisdiction, and at no additional cost to the Employer.

E. Any damages resulting from tests shall be repaired and/or damaged materials replaced, all to the satisfaction of the Engineer, and at no additional cost to the Employer.

F. The duration of tests shall be as determined by all parties having jurisdiction, but in no case less than the time prescribed in each division of the Specifications.

G. The following tests should be furnished for but limited to the following:-

1. Fire Suppression System Test.

2.3 COORDINATION OF TRADES

A. The Contractor shall coordinate the work to ensure orderly, timely installations of the work of applicable trades within the various spaces indicated.

2.4 ACCESS DOORS

A. Access doors shall provide ready access to concealed control valves, traps, cleanouts, motors, fire dampers, and other items requiring operation, adjustment, or maintenance.

B. Doors and frames shall be of 12-gauge galvanized steel with invisible hinges, and cam lock fastenings. For plaster walls or ceiling, frames shall have a 50 mm. wide lath plaster bond. For masonry walls, the frame shall be set flush with masonry with provisions in the jamb for anchoring. Doors shall be solid flush steel with grey metal primer. Location of access doors shall be coordinated with and shall have the approval of the Engineer before the mechanical work is
installed.

2.5 PERMITS

A. The Contractor shall obtain and pay for all necessary permits, inspections and tests, for the proper installation of his work, as may be required by the various administrative authorities having jurisdiction.

B. Certificates of inspections, tests etc., with the proper approval certified thereon, shall be secured by the Contractor and these documents shall be delivered to the Engineer before the work in question will be accepted.

2.6 OPENINGS IN EXTERIOR WALLS

A. Openings in exterior walls, particularly at or below grade shall be kept properly plugged and caulked at all times, (except when being worked on) to preclude the possibility of flooding due to storms or other causes. After completion of work, openings shall be permanently sealed and caulked in the manner herein specified.

2.7 TRENCH BOTTOM GRADING

A. All trench bottom grading required for plumbing work shall be done under the requirements of this section of the Specifications. The bottom of all trenches shall be trimmed by hand method to receive pipes at their respective finish levels. Trenches shall not be excavated by machine below levels as above specified.

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PART 3  EXECUTION
  3.1  Pipe Sleeves
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PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

A. Pipe bending shall not be resorted to except in extreme cases and only after the written approval of the Engineer.
B. Piping shall be designed with Loops to take the thermal expansion. Wherever this is not possible for physical reasons, expansion joints with guides shall be used.
C. Installation of pipes shall be complete with all cutting, patching and making good of walls, slabs, partitions, etc., due to fixing, supporting and anchoring of pipes.
D. Automatic air vents shall be installed at all air pocket locations, and/or at the highest points in the lines.
E. Pipes and fittings shall both be manufactured according to one single standard unit of measurement, either both English or both metric.
F. Provision shall be made for flushing the system.
G. All piping shall be installed so that the system may be thoroughly drained.
H. The piping shall be pitched in the direction of drainage.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 10 44 00 - Fire Protection Specialties
B. Section 21 05 23 - General Duty Valves for Fire Suppression Piping
C. Section 21 05 29 - Hangers and Supports for Fire Suppression Piping
D. Section 21 05 53 - Identification for Fire Suppression System

1.3 CODES AND STANDARDS

Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance/manufacturing standards of items mentioned in this section shall conform to the applicable portions of the latest editions of the following codes, standards and regulations.

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<td>-</td>
<td>The LPC rules for automatic sprinkler installations</td>
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</table>
PART 2 – PRODUCTS

2.1 PIPE EXPANSION JOINTS

A. Supply and install expansion joints wherever pipes cross structural expansion joints and wherever required to prevent undue stresses caused by thermal expansion of the pipes.

B. Expansion joints shall be of the packless-bellow type with flanged or welded ends as suitable for the pipe application.

C. Bellows shall be of stainless steel and suitable for a pressure of 125 psi (860 Kpa) or the design working pressure, whichever is greater. Expansion joints shall be provided with guides to prevent any unnecessary misalignment of the pipe. Guides and anchor arrangements shall be per the recommendations of the expansion joints manufacturers.
PART 3 – EXECUTION

3.1 PIPE SLEEVES
A. Piping shall be pitched to permit complete draining of the system.
B. Provide all pipe openings through walls, partitions and slabs with sleeves having an internal diameter at least 50mm larger than the outside diameter of the pipe for uninsulated lines or of the insulation for insulated pipes.
C. Install sleeves through interior walls and partitions flush with finished surfaces; sleeves through outside walls to project 15mm. on each side of the finished wall; and floor sleeves to project 25mm. above finished floors.
D. Set sleeves in place before pouring concrete or securely fasten and grout in with cement.

3.2 CLEANING OF PIPING SYSTEMS
A. Plug all opening ends of piping, valves and equipment except when actual work is being performed to minimize accumulation of dirt and debris.
B. Prior to the performance of tests, flush out all piping that is to receive a hydrostatic test with clean water.
C. Remove dirt and debris collected at screens, strainers and other points from the system.

End of Section 21 05 16
SPECIFICATION SECTION 21 05 19
METERS AND GAGES FOR FIRE-SUPPRESSION SYSTEMS

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PART 1  GENERAL
1.1 Approvals
1.2 Requirements
1.3 Related Work Specified Elsewhere
1.4 Codes and Standards

PART 2  PRODUCTS
2.1 Pressure Gauges
2.2 Flow Meters
PART 1 – GENERAL

1.1 APPROVALS
A. No items shall be installed in breach of any of the existing local Fire Department regulations. In all access, however, installation shall comply with National Fire Codes (NFPA latest editions).

1.2 REQUIREMENTS
A. Supply and install wherever shown on the drawings all materials specified in the capacities and ratings indicated on the drawings.

1.3 RELATED WORK SPECIFIED ELSEWHERE
A. The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated herein verbatim.

1. Section 10 44 00 - Fire Protection Specialists
2. Section 21 05 16 - Expansion Fittings and Loop for Fire Suppression Piping
3. Section 21 05 23 - General Duty Valves for Fire Suppression Piping
4. Section 21 05 29 - Hangers and Supports for Fire Suppression Piping
5. Section 21 05 53 - Identification for Fire Suppression System

1.4 CODES AND STANDARDS
A. Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance/manufacturing standards of items mentioned in this section shall confirm to the applicable portions of the latest editions of the following codes, standards and regulations.

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<td>3. Loss Prevention Council</td>
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</table>
PART 2 – PRODUCTS

2.1 PRESSURE GAUGES

A. Bourdon-tube type with 120 mm. diameter cast aluminium case with moisture-proof and dustproof blowout discs. Panel mounted gauges to have steel or aluminium hinged rings; direct mounted gauges to have back flange, black numerals on a white background face.

B. Pressure gauge shall be furnished with a lever-operated gauge cock, and shall have snubbers installed between the gauge cock and the gauge to eliminate pulsations.

C. Bourdon Tube shall be Phosphor bronze, (beryllium copper bellows).

D. Socket shall be Stainless steel.

E. Accuracy shall be at least 1% of scale range, shall be equal to twice the rated working pressure of the unit (pumps, chillers) reading shall be in psi. and Kpa.

F. Gauges for combined pressure and vacuum service to have compound seal.

2.2 FLOW METERS

A. Supply and install flow meters at the pump test flow line, as shown on drawings. The meter connections and cocks shall be carried well above the line. Install the flow meters in accordance with the manufacturer’s recommendation, as per Authority and Fire Department regulations.

End of Section 21 05 19
### SPECIFICATION SECTION 21 05 23

**GENERAL - DUTY VALVES FOR WATER-BASED FIRE - SUPPRESSION PIPING**

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PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS
A. Drain valves shall be provided where necessary, where shown on the Drawings and at all sectional valves to help draining the major part of the system. On all risers 4” (100mm) or larger, drain valve shall be 2” (50 mm) size, on 2½” (65 mm) and 3” (80mm) risers, 1¼” (32 mm) valves shall be used and on small risers, ¾” (20mm) drain valves shall be provided.
B. All valves controlling the water supply shall be located where readily accessible.
C. Provision shall be made for test connections and valves.
D. Control power transformer as applicable to limit control voltage to 24 VDC maximum.

1.2 RELATED WORK SPECIFIED ELSEWHERE
A. The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated herein verbatim.
1. Section 10 44 00 - Fire Protection Specialists
2. Section 21 05 16 - Expansion Fittings and Loop For Fire Suppression Piping
3. Section 21 05 29 - Hangers and Supports for Fire Suppression Piping
4. Section 21 05 53 - Identification for Fire Suppression System

1.3 CODES AND STANDARDS
Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance/manufacturing standards of items mentioned in this section shall conform to the applicable portions of the latest editions of the following codes, standards and regulations.

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</tbody>
</table>
PART 2 – PRODUCTS

2.1 FLOW SWITCH - ELECTRIC TYPE
A. The water flow alarm device shall consist of an electrical switching device actuated by means of a vane extending inside the pipe so designed that when water flows inside the pipe the moving vane shall close the circuit in the motor switch which shall complete the circuit and actuate an alarm.

2.2 GEAR BOX AND MONITOR
A. Supply and install gear box with internal monitor switch for each monitored type isolating valve in the sprinkler system.
B. The box and the switch shall be UL listed and approved by FM. The switch shall be two single pole, double throw type and it shall be connected to the BMS and the fire alarm panel so that the movement of the valve disc. from the full open position will register an instantaneous warning in the BMS and fire alarm panel in order to restore the integrity of the system.

2.3 SIAMESE CONNECTION
A. Siamese connection shall comply with BS 336 and to be installed where shown on Drawings at a convenient height from finished side walk level and shall be chrome plated extra heavy cast brass complete with the following:
B. 6" x 2½" x 2½" x 2½" x 2½" (150 x 65 x 65 x 65 x 65 mm) as shown on drawings Siamese connection with drain cock and check valves to suit local practice.
C. All chains, caps and screws used for fixing.
D. Recessed wall box housing the Siamese connection of 2mm stainless steel mirror finish type 316L, GR7 sheet with wired glass door marked in red from inside: "FIRE BRIGADE CONNECTION" in both English and Arabic.

2.4 BRANCH ORIFICE
A. Branch Orifice Plate should be installed as required by LPC or NFPA.
B. Select orifice flange for circuit flow range and minimum pressure drop across the orifice.
C. Orifice type of flow station to be inserted between flanges. Cast iron body suitable for operating pressures to 2069 kPa at 121oC. Readout valves of brass construction with integral EPT check valve. Calibration plate mounted on unit.

2.5 DEAD WEIGHT FIRE VALVE & ACCESSORIES
A. Dead Weight Fire Valve & Accessories supply and install wherever shown on the drawing and wherever specified fire valves. The fire valve shall be a weight-operated glandless cast iron rotary plug-type screwed valve, internally lubricated. The valve should not leak, stick or jam, and shall be unaffected by the pressure in the system. The valve shall be suitable for use with pressure up to 1379 x 103M/m2. (200 lbs./sq.in.).
PART 3 – EXECUTION

3.1 CLEANING OF PIPING SYSTEMS
A. Plug all opening ends of piping, valves and equipment except when actual work is being performed to minimize accumulation of dirt and debris.
B. Prior to the performance of tests, flush out all piping that is to receive a hydrostatic test with clean water.
C. Remove dirt and debris collected at screens, strainers and other points from the system.

3.2 PIPE INSTALLATION
A. Provide all pipe openings through walls, partitions and slabs with sleeves having an internal diameter at least 50mm larger than the outside diameter of the pipe for un-insulated lines or of the insulation for insulated pipes.
B. Install sleeves through interior walls and partitions flush with finished surfaces; sleeves through outside walls to project 15mm. on each side of the finished wall; and floor sleeves to project 25mm. above finished floors.
C. Set sleeves in place before pouring concrete or securely fasten and grout in with cement.
D. Sleeve construction:
   1. Interior Partitions - galvanized sheet iron.
   2. Interior & Exterior Masonry Walls and Floors-galvanized steel pipe.
E. Fill the space between outside of pipe or insulation and the inside of the sleeve or framed opening with fibrous asbestos in interior walls and floors and pack with oakum, seal with watertight mastic or asphalt in exterior walls.

End of Section 21 05 23
# SPECIFICATION SECTION 21 05 29

## HANGERS AND SUPPORTS FOR FIRE SUPPRESSION PIPING

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PART 1 – GENERAL

Works of this Section shall be governed by Conditions of Contract and it’s requirements.

1.1 HANGERS AND SUPPORTS, ANCHORS AND GUIDES - GENERAL

A. Support, anchor and guide all piping to preclude failure or deformation. Construct and install hangers, supports, anchors, guides and accessories to the approval of the Engineer. Do not use wire, tape or metal bands. Supports shall be designed to support weight of pipe, weight of fluid and weight of pipe insulation.

B. Fasten piping securely to the structure without overstressing any portion of the supports or the structure itself. Secure pipe supports, anchors and guides to concrete by means of inserts or if greater load carrying capacity is required by means of steel fishplates embedded in the concrete.

C. Arrange hanger to prevent transmission of vibration from piping to building and supports.

D. Un-insulated copper or brass pipe and/or tubing shall be isolated from ferrous hangers or supports.

E. Support piping and tubing at intervals indicated in the schedule hereinafter and at all changes in direction. Maximum deflection shall not exceed 3 mm.

F. Clearance for application of specified Vapour sealed insulation without cutting pipeline covering or fitting covering in installation of pipe hangers and fittings shall be provided.

G. Furnish pipe hangers and supports complete with rods, bolts, lock nuts, swivels, couplings, brackets and all other components and accessories, to allow installation to freely expand and contract.

H. Hangers shall be formed steel clevis type, unless otherwise specified, with adjustable attachment to hanger rod. For copper or brass pipe, use plastic sheathed hangers. Pipe hangers shall fit over vapour sealed insulated piping.

I. Where pipe exceeds maximum loading recommended for clevis type hanger, provide steel pipe clamps.

J. Provide trapeze hangers where several pipes can be installed parallel and at the same level. Trapeze shall be of steel channel sized to support load and drilled for rod hanger at each end. Provision should be made to keep the lines in their relative position to each other by the use of either clamps or clips.

K. Use roller supports, where provision for expansion is required. Rollers shall have cast iron adjustable bases.

L. For hanger rods on piping 3/8" (10 mm) thru 2" (50 mm) inclusive use 3/8" (10 mm) rods, and for piping 2 ½" (65 mm) thru 5" (125 mm) use 5/8" (16 mm) rods, and for piping 6"(150 mm) thru 12" (300 mm) use 7/8" (22 mm) rods.
M. Provide additional steel members required for hanging piping systems in areas with special conditions, or where vertical or horizontal structural steel supports are required other than those provided in the structure.

N. Provide lateral bracing for supporting rods over 450mm. long braced at every fourth hanger with diagonal bracing attached to slab or beam.

O. Floor supports - provide for supporting horizontal piping from floors with cast-iron rests, with pipe nipples to suit. Fasten to floor. Where provision for expansion is required, provide pipe roll stands, without vertical adjustment. Provide concrete or steel pipe piers, fasten stands to piers.

P. Wall supports - provide for supporting horizontal piping from wall with steel J-Hook for pipe located close to wall and not larger than 3" (80 mm) pipe. For greater loads, up to 1500 lbs (680 Kg) maximum loading provide welded steel bracket.

Q. Pipe-covering (insulation) protection saddles.

R. Provide hanger shields to protect vapor sealed pipe insulation within mechanical equipment rooms at each support point by a 360 degree insert of high density, 100 psi, waterproofed calcium silicate encased in a 120 ° sheet metal shield. Insert thickness shall be same as insulation. Shield length shall equal nominal pipe diameter, minimum but shall not be shorter than 100mm. and need not be longer than 300mm. if bearing load causes no discernable deformation. Insert shall extend 25mm. beyond sheet metal shield. 100mm. shields shall be 26 gauge minimum. Shields 130 to 230mm. long shall be 20 gauge minimum. Shields longer than 230mm. shall be 16 gauge.

S. Provide penetration shields to encase insulated pipes penetrating fire walls or floors in a 360 °, 24 gauge minimum sheet metal hanger shield with insert of high density, 100 psi. waterproofed calcium silicate the same thickness as insulation and further enclosed within the sleeve, sized for maximum 25mm. spacing between sleeve and insulation shield, pack annular space between sleeve and shield on both ends with double neoprene coated asbestos rope. Install an escutcheon plate to completely cover the wall penetration opening and fit snugly over the pipe insulation shield. Insert shall extend at least 25mm. beyond penetrated surface and escutcheon.

T. Provide oversize hangers with blocking the same thickness as the insulation to pitch vapor sealed insulated pipes accurately at time of insulation.

1.2 Horizontal Piping Support Schedule

A. For fire protection piping:
   .1" & 1¼" (25 & 32 mm) steel pipe ------------------------ 3.7 meter.
   .1½” – 8” (40 – 200 mm) steel pipe ------------------------ 4.6 meter.

B. Vertical spacing of steel pipes - at every floor level.

End of Section 21 05 29
SPECIFICATION SECTION 21 05 53
IDENTIFICATION FOR FIRE SUPPRESSION SYSTEM

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1.2  Scope of Work
1.3  Related Works Specified Elsewhere
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PART 2  PRODUCTS
2.1  Valve Chart Locations
2.2  Identification of Pipelines And Services
2.3  Sign and Accessory Fastening
2.4  Nameplates
2.5  Painting
PART 1 – GENERAL

1.1 INTRODUCTION
A. To be read and governed by general conditions of contract and its Sections. This section includes the identification of all pipe works, equipment etc.

1.2 SCOPE OF WORK
A. The Contractor shall be responsible for submitting complete above works based on specifications and consultant’s approval of samples.

1.3 RELATED WORKS SPECIFIED ELSEWHERE
A. Section 21 05 00 - Common Work Results For Fire Suppression.
B. Section 21 05 16 - Expansion Fittings And Loop For Fire Suppression Piping.
C. Section 21 05 29 - Hangers And Supports For Fire Suppression Piping.

1.4 REFERENCE STANDARDS
A. BS 1710 Identifications of Pipe Lines and Services.
B. BS 4800 Paint Colours for Building Purposes.
C. DW 144 Specification for Sheet Metal Ductwork.
PART 2 – PRODUCTS

2.1 VALVE CHART LOCATIONS

A. Valve charts shall be provided for each piping system and shall consist of schematic drawings of piping layouts, showing and identifying each valve and describing its function. Two copies of each chart, sealed to rigid backboard with clear lacquer placed under glass and framed, shall be mounted in the building as directed by the Engineer.

2.2 IDENTIFICATION OF PIPELINES AND SERVICES

A. General

1. All Building Services including piping, ducting, electrical conduits and their covering shall be properly identified in accordance with BS 1710, Latest Edition.

2. All methods of identification shall be compatible with the pipe and operating conditions.

3. Identification shall be accomplished by using basic identification colours with code indications.

4. Code indication shall include safety colours and service information. Information shall be given regarding the nature of the contents of the pipe by using the following systems, individually or in combination:-

   a) Name in Full.

   b) Abbreviation of Name

   c) Chemical Symbol

B. Legend

1. The material in piping system shall be identified. Primary identification should be by means of a lettered legend naming the material conveyed by the piping in full or abbreviated form. Arrows shall be used to indicate the direction of flow.

2. The legend shall be brief, informative, pointed, and simple. Legends shall be applied close to valves and adjacent to changes in direction, branches, where pipes pass through walls or floors and as frequently as needed along straight runs to provide clear and positive indication. Identification maybe applied by stencilling, tape or markers.

3. Pipe marking should be highly visible.

4. The Type & Size of Letters

   a) Outside diameter of Length of colour Height of letter

   b) pipe or covering (mm) field (mm) (mm)

   c) (13 to 32) mm 200 mm 13 mm

   d) (40 to 50) mm 200 mm 19 mm

   e) (65 to 150) mm 300 mm 32 mm
f) (200 to 250) mm 600 mm 63 mm

g) over 250 800 mm 100 mm

C. Colour

1. The Colour should be shown on the piping, but in combination with a legend. The application of colour bands shall be done by: Painting, Adhesive colour bands or equivalent colour clips.

2. Colour reference shall be in accordance with BS 4800, Latest Edition.

D. Color Code Indication for Building Services and Pipelines should be as follows:

1. Colour Code
2. Basic colour Identification
3. Fire quenching materials
4. (water, FM200, etc.) Green Red

2.3 SIGN AND ACCESSORY FASTENING

A. Warning and instruction signs, wherever specified or otherwise required, shall be securely fastened where shown or directed with bolting anchors herein specified for masonry construction or round head chrome plated brass wood screws and washers for wood construction. Signs shall not be hung loose on chains or by any other method wherein the sign will be free to move. Sign shall be installed in a conspicuous well lighted location adjacent to the equipment it refers to and shall be easily read by occupants in standing position on floor.

B. All accessories such as wrenches specified to be hung on chain adjacent to the equipment they serve, shall be arranged for stowing in a rigid manner and shall not be hung loose, or otherwise, that may permit the chain or wrench to move or rattle.

2.4 NAMEPLATES

A. Each unit of equipment shall be identified by a permanently attached nameplate made of brass or other corrosion-resistant metal. Plates shall be not less than forty (40) by eighty (80) mm. Plates shall bear information pertaining to the unit as follows:

1. System and unit designation from schedule of equipment.
2. Manufacturer's name and address.
3. Serial and model number.
4. Rated capacity.
5. Temperature, pressure or other limitations.

2.5 PAINTING

A. General Requirements
1. Surface requiring prime painting shall be cleaned thoroughly of all rust, loose scale, oil, grease and dirt. Use wire brushes and solution for this purpose.

2. No painting shall be applied to damp or frosty surfaces in wet, foggy or freezing weather.

3. Paint shall be evenly spread and well brushed out so that there shall be no drops, runs or sagging.

4. Shop coated surfaces shall be cleaned thoroughly and retouched where necessary.

5. Care shall be taken not to paint controls, label plates, nameplates on all apparatus and non-ferrous refrigerant piping.

6. All items that have rusted or corroded in storage or in place shall be re-cleaned or repainted upon request of the Engineer.

7. Finishing coats shall be made in accordance with a color code, based on ASHRAE recommendations after being submitted to and approved by the Engineer.

B. Machinery

2.5.B.1 All machinery installed under this contract such as motors, pumps, etc. shall have a shop priming coat of gray lead and oil.

C. Piping

1. All un-insulated and unwrapped Ferrous piping (galvanized or non-galvanized) including flanges, bolts and valves in trench, partitions, below tiles, or underground shall be painted with 2 coats of emulsified asphalt. All metal surfaces located within or directly adjacent to fresh air intake louvers except fresh air dampers shall be painted with 2 coats, of emulsified asphalt.

2. Paint all exposed (in shafts, above and below false ceiling, on roof, etc.) ferrous piping (including galvanized steel) system components including pipe, fittings, unions, flanges, valves, hangers and supports as follows before wrapping or insulating the pipes (if applicable).

3. Applicable to galvanized pipes:
   a) Prime Coat: Zinc Chromate.
   b) Finish Coat: Ironhide gray metal paint or as approved by the Engineer.

4. Applicable to all other ferrous pipes:
   Prime Coat: Red lead Primer, 1.5 to 2.0 mils thick.

D. Iron Work

1. All iron work within the building, not otherwise specified such as pipe and duct hangers and supports, and supports for apparatus, shall be prime painted with one coat of red lead.

End of Section 21 05 53
### PART 1  GENERAL

1.1 General Requirements
1.2 Controls
1.4 Maintenance During Defects Liability Period and Guarantees.
1.5 Extend Defects Liability and Guarantees.
PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS

A. All piping and equipment shall be tested as specified under the relevant subsection of the specification.

B. Labour, materials, instruments, power etc., required for testing shall be furnished by the Contractor unless otherwise indicated under the particular section of the Specification.

C. Test shall be performed in the presence of representatives of the Engineer and such other parties as may have legal jurisdiction.

D. In general, pressure tests shall be applied to piping system only, before connection of fixtures, equipment and appliances. In no case shall any piping, fixtures, equipment or appliances be subjected to pressure exceeding the ratings as prescribed by the manufacturers of fixtures, equipment and appliances or accepted engineering standards for piping and fittings.

E. All defective work shall be promptly repaired or replaced and the tests shall be repeated until the particular system and component parts thereof receive the approval of the Engineer and authorities having jurisdiction, and at no additional cost to the Employer.

F. Any damages resulting from tests shall be repaired and/or damaged materials replaced, all to the satisfaction of the Engineer, and at no additional cost to the Employer.

G. The duration of tests shall be as determined by all parties having jurisdiction, but in no case less than the time prescribed in each subsection of the specification.

H. In the event of any repair or any adjustment having to be made other than normal running adjustment, the test shall be void and shall be repeated after the adjustment or repairs have been made.

I. When pipes, valves, equipment etc., are to be covered or embedded or insulated; their specific tests shall be carried out on them before any covering is applied. These tests shall not relieve the contractor of any of his responsibilities and he shall take all necessary precautions to insure the safety and protection of such tested items until the termination of the work.

J. Three copies of all test results shall be submitted to the Engineer.

1.2 CONTROLS

A. All controls shall be tested for proper functioning in accordance with the requirements of the Specification.

1.3 MAINTENANCE DURING DEFECTS LIABILITY PERIOD AND GUARANTEES

A. Starting from the date of issue of the Substantial/Provisional completion certificate the contractor shall be responsible, for the duration of one year, to provide the following services free of charge, at his own cost.
B. The training of operators assigned by the client for operation of all major equipment and controls as decided by the Engineer.

C. Training should be provided by original suppliers of equipment for a period of at least one week and or when requested by client throughout the liability period.

D. The replacement of parts or whole equipment that show any manufacturing or installation defects during operation.

E. Guarantee of every piece of equipment from any manufacturing or installation defects for a period of one year.

F. At the end of defects liability period the contractor shall be responsible for final handing over of all installed systems in a perfect condition to the satisfaction of both Engineer and client.

1.4 EXTENDED DEFECTS LIABILITY AND GUARANTEES

A. The Contractor shall issue in favour of the client all original manufacturers extended guarantees as required by specifications or by Engineers approval conditions or by manufacturers initial proposal prior to final handing over to the client.

1.5 CODES AND STANDARDS

A. Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance/manufacturing standards of items mentioned in this section shall confirm to the applicable portions of the latest editions of the following codes, standards and regulations.

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## SPECIFICATION SECTION 21 11 00
### FIRE SUPPRESSION PIPING

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### PART 2  PRODUCTS
- 2.1 Fire Suppression Pipe

### PART 3  EXECUTION
- 3.1 Installation
- 3.2 Cleaning of Piping Systems
- 3.3 Approved List of Manufacturers
PART 1 – GENERAL

Works of this Section shall be governed by Conditions of Contract and it’s requirements.

1.1 GENERAL REQUIREMENTS

A. Pipe bending shall not be resorted to except in extreme cases and only after the written approval of the Engineer.

B. Piping shall be designed with Loops to take the thermal expansion. Wherever this is not possible for physical reasons, expansion joints with guides shall be used.

C. Installation of pipes shall be complete with all cutting, patching and making good of walls, slabs, partitions, etc., due to fixing, supporting and anchoring of pipes.

D. Automatic air vents shall be installed at all air pocket locations, and/or at the highest points in the lines.

E. Pipes and fittings shall both be manufactured according to one single standard unit of measurement, either both English or both metric.

F. Provision shall be made for flushing the system.

G. All piping shall be installed so that the system may be thoroughly drained.

H. The piping shall be pitched in the direction of drainage.

I. Drain valves shall be provided where necessary, where shown on the Drawings and at all sectional valves to help draining the major part of the system. On all risers 4" (100mm) or larger, drain valve shall be 2" (50 mm) size, on 2½" (65 mm) and 3" (80mm) risers, 1¼" (32 mm) valves shall be used and on small risers, ¾" (20mm) drain valves shall be provided.

J. No direct interconnections shall be made between sewers and fire drain systems.

K. Fire piping shall not be used, in any way, for domestic water supply purposes.

L. All valves shall be located where readily accessible.

M. Provision shall be made for test connections and valves.

N. Control power transformer as applicable to limit control voltage to 24 VDC maximum.

1.2 TESTS

A. The system shall be subjected to a hydrostatic pressure test, to the satisfaction and in the presence of the Engineer. Pressure shall not be less than 300 psi (2070 Kpa) or at 50 psi (345 Kpa) in excess of the maximum static pressure when the maximum static pressure is in excess of 150 psi (1030 Kpa) and the test shall be maintained for two hours.

B. If leaks develop during the test, the contractor shall make all necessary repairs and shall retest the system at no additional cost to the Employer.
1.3 RELATED WORK SPECIFIED ELSEWHERE

A. The works specified in the following divisions, sections and sub-sections are included in this Section in each applicable part, as if repeated herein verbatim.

1. Section 10 44 00 - Fire Protection Specialists
2. Section 21 05 16 - Expansion Fittings and Loop For Fire Suppression Piping
3. Section 21 05 23 - General Duty Valves for Fire Suppression Piping
4. Section 21 05 29 - Hangers and Supports for Fire Suppression Piping
5. Section 21 05 53 - Identification for Fire Suppression System

1.4 CODES AND STANDARDS

A. Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance/manufacturing standards of items mentioned in this section shall conform to the applicable portions of the latest editions of the following codes, standards and regulations.

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PART 2 – PRODUCTS

2.1 FIRE SUPPRESSION PIPE

A. Pipes above ground shall be of the ERW type galvanized steel pipes to B.S. 1387 "medium weight" or ASTM A 53-88a Sch. 40. All pipe fittings elbows, tees, crosses, unions, reducers, etc. shall be of the same quality and weight as the pipes.

B. Pipe fittings 2" (50 mm) and smaller shall be suitable for threaded connections, 2½" (65 mm) and larger shall be flanged / grooved fittings.

C. Unions and grooved fittings, flanges shall be installed at all valves inlets or outlets, on all pipe branches and in general, every 15 metres of pipe run.

D. Unions shall be used on all screwed pipes and shall be of the same quality and service. Grooved fittings shall be used on all pipes above 2½" and shall be all steel construction to ASTM or BS Standards.

E. Contractor shall rectify any damage to the pipes from the processes of grooving to the satisfaction of the Engineer.

F. Pipes underground shall be HDPE to ISO 4427, PE 100 resin all fittings shall be electrofusion and butt fusion types.
PART 3 – EXECUTION

3.1 PIPE INSTALLATION
A. Piping shall be pitched to permit complete draining of the system.
B. Fire standpipe shall not be used in any way to provide water for other purposes.
C. Provide all pipe openings through walls, partitions and slabs with sleeves having an internal diameter at least 50mm larger than the outside diameter of the pipe for un-insulated lines or of the insulation for insulated pipes.
D. Install sleeves through interior walls and partitions flush with finished surfaces; sleeves through outside walls to project 15mm. on each side of the finished wall; and floor sleeves to project 25mm. above finished floors.
E. Set sleeves in place before pouring concrete or securely fasten and grout in with cement.

3.2 CLEANING OF PIPING SYSTEMS
A. Plug all opening ends of piping, valves and equipment except when actual work is being performed to minimize accumulation of dirt and debris.
B. Prior to the performance of tests, flush out all piping that is to receive a hydrostatic test with clean water.
C. Remove dirt and debris collected at screens, strainers and other points from the system.

3.3 APPROVED LIST OF MANUFACTURERS
A. For acceptable Products, Manufacturers and Suppliers, refer to Appendix A.

End of Section 21 11 00
SPECIFICATION SECTION 21 22 00
FM200 SYSTEM

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PART 1 – GENERAL

1.1 DESCRIPTION OF WORK
A. Design and installation of clean agent/waterless fire suppression system employing DuPont FM-200 agent.
B. All drawings are to be reviewed by the contractor so any items which may affect the operation of the fire suppression system(s) are taken into account when designing the system.

1.2 APPLICABLE STANDARDS & PUBLICATIONS
A. The design, installation, testing and maintenance of the clean agent fire extinguishing system, shall be in accordance with the requirements in the following codes, standards and regulatory bodies:
   1. NFPA 2001: Standard for Clean Agent Fire Extinguishing Systems
   2. NFPA 70: National Electrical Code (NEC)
   5. Factory Mutual Approval Guide
   6. ANSI B1.20.1: Standard for pipe threads, General Purpose
   7. Requirements of the Local Authorities Having Jurisdiction (AHJ)
B. The complete system shall have the applicable following listings and approvals:
   1. Underwriters Laboratories (UL)
   2. Factory Mutual Global (FM)
   3. Underwriters Laboratories of Canada (ULC)
C. All components of the clean agent fire extinguishing system shall be the products of the same manufacturer or listed by that manufacturer as compatible with those devices components and equipment.

1.3 SUMMARY
A. Section includes:
   1. Extinguishing agent
   2. Extinguishing agent cylinders
   3. Piping and piping specialties.
B. Section Exclusions:
   1. Room sealing requirements shall be communicated and coordinated between the suppression system contractor and the project’s main General Contractor and all subcontractors.
1.4 QUALIFICATIONS OF MANUFACTURER, DESIGNER, AND INSTALLER

1. Manufacturer:
   1. The manufacturer/supplier of the system hardware and components shall have a minimum of fifteen (15) years experience in the design and manufacture of systems of similar type.
   2. The manufacturer/supplier of the systems shall be certified to ISO 9001 for a minimum period of five (5) years for the design, production and distribution of fire detection, fire alarm and fire suppression systems.
   3. All devices, components and equipment shall be the products of the same manufacturer/supplier.
   4. The system manufacturer/supplier shall have the ability to provide multiple suppression system arrangements to accommodate the performance criteria required by the project.

2. Designer/Installer Suppression System Contractor
   1. The suppression system contractor shall be authorized to purchase and trained manufacturer to design, install, test and maintain the ADS system, using FM-200 fire extinguishing agent proposed and shall be able to produce a certificate of training and/or a letter stating they are an authorized supplier of the proposed equipment from the manufacturer, upon request.
   2. The suppression system contractor shall employ a person who can show proficiency equal to a NICET level <II>, <III> or <IV> certification in special hazards design.
   3. The Contractor shall confirm in writing that he stocks a full complement of spare parts and offers 24-hour/7 days a week emergency service for all equipment being furnished.
   4. Maintain or have access to a recharging station capable of recharging the largest suppression system with <48hrs> after discharge.

1.5 SUBMITTALS

A. Supply manufacturers product technical data and catalog cut sheets for each component or device used in the system.

B. Shop Drawings:
   1. Prepared by a person holding at least a NICET Level III certification
   2. Meet all systems design chapter requirements per NFPA 2001 and recommendations in the “Working Plans” section.
   3. Include design calculations for enclosure volume, agent quantity based on required design concentration for each hazard area.
   4. Indication of dimensions, weights and loads of equipment assemblies, components, method of field assembly, clearance requirements, mounting and bracing practices, etc
   5. Isometric piping layouts
   6. Plan and Elevation views
   7. Suppression system equipment locations
C. Flow Calculation Reports:

The distributor shall provide the following information in the flow calculation report:

1. Customer information and project data

2. Hazard information. At a minimum, hazard information shall include the minimum design concentration and adjusted design concentration, minimum and maximum enclosure ambient temperature, minimum agent required, volume of enclosures and any corresponding non-permeable volume, and identify the quantity of discharge nozzles.

3. Cylinder information. At a minimum, cylinder information shall include total agent required, cylinder capacity, cylinder part number, cylinder quantities (both main and reserve), agent fill amount per cylinder and floor loading per cylinder.

4. Pipe network information. At a minimum, pipe network information shall include pipe type, pipe diameter, pipe length, change in elevation, pipe equivalent length and any added accessory equivalent length. In addition, the following nozzle information shall be provided; number of nozzles and identification of enclosure location, flow rate of associated nozzle, nozzle nominal pipe size, nozzle type and nozzle orifice area.

5. Pipes and pipe fittings. A detailed list of pipe, by schedule, nominal diameter and length, and fittings, by nominal diameter and quantity.

D. The architect will review all submittals for conformance to the drawings and specifications. The contractor shall be required to resubmit any materials, with appropriate modifications, that are found to be in non-conformance with the requirements of the drawings and these specifications after review by the architect. Approval of the submittals by the architect shall not relieve the Contractor of their responsibility to meet the requirements of the drawings and specifications.

E. Optional: Three-Way Ball Valve Information. A calculation shall be completed for each directional valve in the piping network that is used to direct agent to a particular hazard area off of a central bank of cylinders. Modeling of the Three-Way Ball Valve shall be shown in the “open/thru” and “closed/to hazard” position.

F. Commissioning Equipment List: The distributor shall provide a commissioning equipment list for each installed clean agent fire extinguishing system. The equipment list shall identify all installed equipment and configurations.

G. Test Plan

3. The distributor shall submit a test plan that describes how the system equipment and room integrity shall be tested. This shall include a step-by-step description of all tests and shall indicate type and location of test apparatus to be used. At a minimum, the tests to be conducted shall be per NFPA 2001 and any additional supplemental tests required by the AHJ. Tests shall not be scheduled nor conducted until the engineer of record approves the test plan.

H. Installation Drawings

1. Four (4) sets of installation drawings for each installed clean agent fire extinguishing system and one (1) set of the calculation report (if not included in the drawings themselves), owner’s manual and product data sheets shall be submitted to the end-user/owner.

2. Upon completion of installation and commissioning acceptance, two (2) sets of “As-Built” installation drawings and One (1) set of the calculation report (if not incorporated into the drawings files) for each installed clean agent fire extinguishing system shall be given to the owner/end-user for use and reference.
I. Operation and Maintenance Manuals
A. Two (2) copies of Design, Installation, Operation and Maintenance Manual for the ADS clean agent fire extinguishing system employing FM200 shall be submitted after complete installation.

1.6 WARRANTY
A. Components provided by the manufacturer shall carry a warranty of thirty-six (36) months from date of shipment from the manufacturer’s facility or one (1) full year from the date of installation.
PART 2 – PRODUCTS

2.1 SYSTEM DESCRIPTION

A. The system shall be FM-200 agent and shall consist of FM-200, agent cylinder(s) with agent at vapor pressure, seamless nitrogen driver cylinder(s) pressurized to 1800-psig at 70°F (124 bar at 21°C), Actuation hardware and discharge nozzle(s) attached to a pipe network. The ADS system shall be engineered for total flooding of the hazard being protected. The design of this system will be for Class A, B, and C fires as determined by the areas being protected.

B. Agent Concentration Requirements:

a) Achieve a 6.7% (v/v) extinguishing concentration for Class A (Surface Type Fires) hazards.

b) Achieve a 8.7% (v/v) or greater, as required, extinguishing concentration for Class B (Flammable Liquids) hazards. Refer to Design, Installation, and Operations manual for design concentration guidance of Class B fuels.

c) Achieve a 7.0% (v/v) extinguishing concentration for Class C (Energized Electrical Equipment) hazards.

Note: Design Concentrations shall not exceed the agents Lowest Observed Adverse Effects Level (LOAEL) as published in NFPA 2001

a) ADS Cylinder(s) shall be capable of being remotely stored away from the protected hazard while still being able to deliver its 95% of its contents within 10 seconds, which can be verified through the ADS flow calculation program.

2.2 SYSTEM PERFORMANCE

A. System Discharge:

The discharge time required to achieve 95% of the minimum design concentration for flame extinguishment shall not exceed 10 seconds.

B. Duration of Protection:

85% of the minimum design concentration shall be maintained for 10-minutes or a sufficiently longer period of time to allow effective emergency action by trained personnel.

C. Minimum System Design Limits:

1. Nozzles:

a) Nozzles shall be listed and approved for a minimum height of 1 foot (0.31 m) to a maximum height of 16.0 feet (4.87 m) above the floor.

b) Nozzle area coverage for both 360-and 180-degree nozzles shall be a maximum of 46ft x 56-ft (14.0-m x 17.0-m).

2.3 CYLINDER LOCATIONS

A. The cylinders of the this advanced delivery system must be able to be stored/located up to 180ft away from the protected hazard.
B. The location chosen to remotely store/locate the cylinders from the protected hazard must verify its ability to deliver agent to the protected space in the required amount of time through the agent/system calculation software. The inability to meet the design requirements by any system will be considered as not meeting the specifications intent.

2.4 PIPE AND FITTINGS

A. Distribution piping, and fittings, shall be installed in accordance with NFPA 2001, approved piping standards and the engineered fire suppression system manufacturer’s requirements.

B. Piping materials shall be Schedule 40 black iron, galvanized, stainless steel, or chrome plated conforming to ASTM A106 Seamless Grades A, B or C; Schedule 40, ASTM A53 ERW Grades A or B; Schedule 40, ASTM A53 F Furnace Welded; Schedule 40

C. Ordinary cast iron pipe shall A-120 steel pipe and non-metallic pipe shall not be used

D. All fittings shall be 300lb Class fittings conforming, Class 300 malleable or ductile iron up to 6 inch (152mm), Class 300 flanged joints up to 8 inch (203mm), 500 lb. rated grooved up to 8 inch (203mm)

E. Class 150 and cast-iron fittings shall not be used

F. Nozzles shall be braced to prevent any movement in the horizontal or vertical planes

G. Pipe unions are acceptable

H. Inlets and Outlets of Tees can be on the vertical plane

I. All piping shall be supported in a close as possible to concentrated loads and each change in direction. Hanger spacing’s to be installed in accordance with pipe design practices and hanger manufacturers recommendation on spacing.

J. All pipe must be reamed and cleaned prior to assembly to remove burrs and cutting oils

K. The use of Teflon tape or Joint Compound is acceptable, but should only be applied to the male threads

2.5 ACTUATION HARDWARE

A. The agent cylinders shall be actuated in accordance with the applicable design manual.

B. While in the stand-by condition, actuators attached to the cylinder valve shall not be exposed to the cylinder’s internal pressure so as to avoid introducing additional leak paths or accidental discharges.

C. Solenoid actuators shall not require scheduled periodic replacement.

D. The suppression panel shall be UL Listed per UL 864, 9th Edition with the interfacing electric actuators.

2.6 NOZZLES

A. Total flooding clean agent extinguishing system nozzles shall be made of stainless steel.

B. Each nozzle shall be located in the space per the manufacturer’s guidelines. Nozzles shall have either a 180-or a 360-degree discharge pattern.

C. Each nozzle discharge pattern shall be available in sizes ranging from 1/2-in NPT to 2-in NPT.
D. Within each nozzle size and style, the manufacturer shall offer multiple different orifice areas (minimum of 20).

E. Nozzles shall be UL Listed and FM Approved for use with the manufacturer’s clean agent extinguishing system employing FM-200.

2.7 AGENT CYLINDER ASSEMBLIES

A. FM-200 shall be stored in cylinders manufactured and marked in accordance with US Department of Transportation (DOT) specification 4BW-500 and Transport Canada (TC) specification 4BW-M34. The agent cylinders shall hold the agent at its vapor pressure at approximately 44 psig @ 70°F (3.0 bar gauge @ 21°C). The external nitrogen propellant shall be stored in seamless cylinders manufactured and marked in accordance with US DOT specification 3AA-2015 and TC specification 3AAM-154. The external nitrogen cylinders shall be conditioned to 1800-psig @ 70°F (124.12 bar gauge @ 21°C). The system manufacturer shall be able to provide US DOT documentation that the registration number marked on the agent cylinder or the nitrogen cylinder corresponds to a manufacturing location at a US address.

1. FM-200 cylinders shall have a safety relief disc on the shoulder of the cylinder.
2. FM-200 cylinders shall have an integral cup check assembly for transfer of nitrogen.
3. FM-200 cylinders shall be equipped with an integral liquid level indicator (LLI). The LLI will allow the agent cylinder to remain connected and secured in place while measuring the agent mass.
4. An optional low pressure switch can be added to the Nitrogen cylinder(s) to provide a means of electrical supervision of driver pressure.

2.8 FIRE EXTINGUISHING AGENT

A. Fire Suppression Agent: Du Pont™ agent (FM-200®) by E.I Du Pont de Nemours and Company.

2.9 OPTIONAL EQUIPMENT

A. When protecting multiple hazard areas from a single supply of FM-200, Three-Way Directional Ball Valves shall be used.

1. The Three-Way Directional Ball Valves shall be UL Listed or FM Approved for use with FM-200 System.
2. The Three-Way Directional Ball Valves shall be installed and located in the piping network per the manufacturer’s guidelines and design manual.
PART 3 – EXECUTION

3.1 CLEAN AGENT FIRE EXTINGUISHING SYSTEM INSTALLATION
A. The system shall be supplied and installed by a factory-authorized. The Distributor shall be trained and certified to design, install and maintain fire suppression system. The distributor shall install the system in accordance with the manufacturer’s design, installation, operation and maintenance manual.

3.2 ELECTRICAL SYSTEM INSTALLATION
A. All electrical enclosures, raceways, and conduits shall be provided and installed in accordance with applicable codes and intended use, and shall contain only those electrical circuits associated with the fire-detection and control system. No circuit or circuits that are unrelated to the fire alarm or suppression system shall be routed through the enclosures, raceways, and conduits dedicated to the fire alarm or suppression system.
B. Splicing of circuits shall be kept to a minimum, and is only permitted in an electrical box suitable for the purpose. Appropriate hardware shall be used to make the wire splices. Wires that are spliced together shall have the same color insulation.
C. White colored wire shall be used exclusively for the identification of the neutral conductor of an alternating-current circuit. Green colored wire shall be used exclusively for the identification of the earth-ground conductor of an AC or DC circuit. Appropriate color-coding shall be utilized for all other field wiring.
D. All electrical circuits shall be numerically tagged with suitable markings at each terminal point. All circuits shall correspond with the installation draw.

3.3 SYSTEM CHECKOUT
A. Entire system shall be checked out, inspected, and functionally tested by factory authorized and trained personnel.
B. Inspection shall be performed in the presence of the owners representative, engineer or architects representative, insuring authority, and/or the local AHJ (Authority Having Jurisdiction)
C. Prior to final acceptance, the contractor shall provide operational and safety training in all concepts of the system to the owners key personnel. Release of clean agent shall not be part of the training requirements

3.4 ROUTINE MAINTENANCE
A. Routine maintenance on equipment shall be performed in accordance with the most current version of NFPA 2001 and the manufacturer’s installation, operation and maintenance manual.

End of Section 21 22 00
## Division 23 00 00
**Heating, Ventilating, and Air-Conditioning (HVAC)**

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### COMMON WORK RESULTS FOR HVAC

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<td>2.3</td>
<td>Coordination of Trades</td>
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<tr>
<td>2.4</td>
<td>Access Doors</td>
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<td>2.5</td>
<td>Permits</td>
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<td>2.6</td>
<td>Openings in Exterior Walls</td>
</tr>
</tbody>
</table>
PART 1 – GENERAL

1.1 GENERAL REQUIREMENTS
A. The work of this Division 23 shall be governed by general conditions of contract and sections of Division – A and generally the following documents:
   2. Instructions to Tenderers.
   3. Form of Agreement.
   4. General and Special Conditions of Contract.
   5. Form of Tender.
   6. Appendices.
   7. Applicable Divisions.
B. It is the Contractors responsibility to be fully aware of and comply with all of the requirements of the above listed documents, and further assure that all Subcontractors are equally informed.

1.2 APPLICATION
This section applies to and is part of all Sections of Division 23.

1.3 SCOPE OF WORKS
A. The works covered under this contract include supply, installation, testing, adjusting and putting into operation systems, components of systems, and individual items of equipment, and work related thereto, in accordance with the project Tender Documents. Products not mentioned but obviously necessary for the completion of those Works shall be provided complete details of all work included in Scope of work like some of the below but are not limited to them.
   1. Include clouded text.
   2. Requirements of fire dampers wherever duct crossing fire wall.
   3. System air balancing and associated requirements for do the balancing
   4. System water balancing and associated requirements for do the balancing.
   5. Insulation of valves and valve boxes.
   6. Maintaining the noise levels as specified
B. Unless specifically mentioned otherwise, the following electrical works and materials for the Mechanical equipment shall be supplied and installed under Division 23 of the specification but in all respect to the requirements of the Electrical Specifications.
C. All control panels including door lock disconnected switches, push buttons, starters, contractors, circuit breakers, time delays, selector switches, relays, transformers, timers, controllers, pilot lights, set points, alarms and all other electrical equipment which are necessary for the satisfactory operation, control and protection of all plant supplied under this section of the specifications.
D. Whenever a number of starters controllers, instruments, indicating lights and the like occur or are shown on the Mechanical and/or electrical Drawings, they shall be arranged in a central position in a neat, easily cleaned, factory-built panel, or motor control center assembly. The assembly shall include isolators and all necessary fuses, busbars, starters, instruments, relays, push-buttons, indicating lights and the like. Components shall be mounted in a logical order based on the sequence of operation.

E. All control equipment including thermostats, sensors, detectors, actuators, controllers, pressure level and flow switches, annunciation alarms, remote control stations and all such equipment needed for the proper system operation.

F. All control wiring for the above mentioned equipment.

G. Final connection, between disconnect switches, power outlets, flex outlet and mechanical equipment.

H. The following electrical works and materials for the mechanical equipment shall be supplied and installed under the electrical part of this contract.
   1. All power supply up to and including the following:
      2. Power outlets for fan coil units.
      3. Disconnect switches when specified to be installed separate from the control panel.
      4. Flex outlet for exhaust fans.
      5. Power supply up to control panels when specified with an integral disconnect switch.
      6. Power supply to disconnect switches when the switches are built-in the equipment.
      7. Empty conduits with pull wires for all cables and wires classified under the mechanical scope of works.
      8. Control outlet boxes for all control equipment classified under the mechanical scope of works.
      9. Power cables and conduits or fixing arrangement between Split Units, etc. and their control panel.
     10. Power cables and conduits from central control panel to the various equipment controlled from the same panel, such as exhaust fans, supply air fans, etc.

1.4 QUALITY ASSURANCE

The manufacturer's of all materials and equipment must have at least ten years of experience in the design and manufacture of their products.

1.5 RELATED WORK SPECIFIED ELSEWHERE

In addition to the sections mentioned above, and unless specifically called in the specification the following works shall be referred with the other related divisions.

1.6 ENGINEER’S DRAWINGS

The Drawings are based on design and include general layouts and typical details of various systems to be installed. The Contractor shall make the installations in a workmanlike manner to conform to the structure, to avoid obstructions, to preserve head room, and to keep openings and passage ways clear without additional instruction and without additional cost to the owner.
1.7 SHOP DRAWINGS AND DATA TO BE SUBMITTED FOR APPROVAL

A. The Contractor shall submit Shop Drawings showing the exact routing and locations of all the piping, ducting, equipment, etc., all in their respective locations and according to the dimensions of the approved manufacturer. Shop Drawings scale shall be 1/10, 1/20, 1/50 and 1/100 as applicable and as approved by the Engineer.

B. The Contractor shall submit catalog cuts and brochures of products with reference to proper paragraph in specifications. All submittals shall be binded in one Booklet.

C. The Contractor shall submit adequate Engineering data on each piece of equipment together with all characteristic curves, capacity selection charts and all data for testing and balancing of the systems. In addition the Contractor shall submit manufacturer's printed installation instructions.

D. The Contractor shall submit at the beginning of the project a schedule of submittals for materials and shop drawings to the approval of the Engineer.

1.8 APPROVED MATERIALS

A. All materials shall be furnished in accordance with the requirements of the Specifications.

B. The naming of manufacturers in the Specifications shall be strictly adhered to in all circumstances.

C. Substitution of materials other than those named shall not be submitted.

D. Materials shall be delivered in unbroken packages bearing the brand and maker's name, and shall be stored on platforms and properly covered to protect them from moisture, heat and dust.

E. All materials shall be supplied from the main factories in the country of origin of the manufacturer. Any deviation from this, like supplying equipment assembled in another different country under a license or another name is not accepted unless approved by the Engineer.

1.9 INSTRUCTION PERIOD

The Contractor shall furnish the services of the control manufacturer (or his representative) to train or instruct the Employer's Representative for a period of five (5) eight (8) -hour days. This period shall follow the final inspection date, and shall be divided into two (2) equal or unequal periods if so requested by Employer.

1.10 MACHINERY GUARDS

A. All moving parts of machinery shall be protected by strong guards to adequately protect all personnel working on or in the vicinity of equipment.

B. Wherever possible, moving parts should be protected by guards supplied by the equipment manufacturer. All guards must be strongly attached to equipment and should be designed to be easily removed for access, servicing, adjustment and maintenance.

1.11 INSTRUCTION MANUAL AND AS-BUILT DRAWINGS

A. The Contractor shall furnish and submit to the Engineer in electronic and hard copy triplicate bound, A4 size, Instruction Manuals containing the following material:
B. Brief description of each system and its service and basic operation features.

C. Manufacturer's mechanical equipment parts list of all functional components of the systems listed on the Drawings, control diagrams and wiring diagrams of controllers. List shall give system No., unit no., Manufacturer's Model No., and Manufacturer's Drawing no. Parts list shall include manufacturer's recommended spare parts for one year operation.

D. Chart of the tag numbers, location and function of each valve.

E. Maintenance instructions for each type of equipment.

F. Possible breakdowns and repairs for each type of equipment.

G. List of nearest local suppliers for all equipment.

H. Manufacturer's literature describing each piece of equipment control diagrams and wiring diagrams of controllers.

I. Complete, as installed, color coded wiring diagrams of all electrical motor controller connections and interlock connections of other mechanical equipment.

J. The Contractor shall furnish all the foregoing to the Engineer for his review as to the fulfillment of the specified requirements.

K. All items shall be available at least four weeks prior to the substantial completion date.

1.12 ABBREVIATIONS

A. The following abbreviations have been mentioned in the specifications.

B. AMCA - Air Moving and Conditioning Associations.


D. ARI - Air Conditioning and Refrigeration Institute.


F. ASHRAE - American Society of Heating Refrigeration and Air Conditioning Engineers.

G. ASME - American Society of Mechanical Engineers.


I. BSI - British Standards Institution.

J. SMACNA - Sheet Metal and Air Conditioning Contractors National Association.

K. UL - Under Writers Laboratories.

L. BTU - British Thermal Units.

1.13 WORKMANSHIP

A. All workmanship required to accomplish the work mentioned in Mechanical specification or shown on related Drawings, shall conform to the highest standards, and as required by the Engineer.

B. The Engineer will be the sole judge of the standards required.
PART 2 – EXECUTION

2.1 CLEANING AND ADJUSTING
   A. All apparatus shall be thoroughly cleaned before being placed in operation. Finished surfaces shall be restored if damaged and entire installation shall be delivered in perfect condition, subject to the approval of the Engineer. Systems shall be adjusted and balanced to operate as shown in the Drawings and herein specified.

2.2 TESTS
   A. All piping and equipment shall be tested as specified under the corresponding section of the Specifications and to meet local and specified requirements. Provide anemometers, thermometers, gauges, voltmeters, ammeters, and similar instruments, not part of the permanent installation, but required to record the performance of the equipment and systems. Labor, materials, power, etc., required for testing, shall be furnished by the Contractor, unless otherwise indicated under the particular section of the Specifications.
   B. Tests shall be performed in the presence of representatives of the Engineer and such other parties that have legal jurisdiction and all results shall be recorded.
   C. In general, pressure tests shall be applied to piping systems only before connection of fixtures, equipment and appliances. In no case shall any piping, fixtures, equipment or appliances be subjected to pressures exceeding the ratings as prescribed by the manufacturers of fixtures, equipment and appliances, or accepted engineering standards for piping and fittings.
   D. All defective work shall be promptly repaired or replaced and the tests shall be repeated until the particular system and component parts thereof receive the approval of the Engineer and authorities having jurisdiction, and at no additional cost to the Employer.
   E. Any damages resulting from tests shall be repaired and/or damaged materials replaced, all to the satisfaction of the Engineer, and at no additional cost to the Employer.
   F. The duration of tests shall be as determined by all parties having jurisdiction, but in no case less than the time prescribed in each division of the Specifications.
   G. The following tests should be furnished for but limited to the following:
      1. Vibration isolation test
      2. Sound attenuator test
      3. Insulation test
      4. Split Unit Tests
      5. Air balancing
      6. Exhaust systems tests
      7. Noise and vibration measurement
      8. Room condition tests
      9. Controls test
2.3 COORDINATION OF TRADES
The Contractor shall coordinate the work to ensure orderly, timely installations of the work of applicable trades within the various spaces indicated.

2.4 ACCESS DOORS
A. Access doors shall provide ready access to concealed motors, fire dampers, and other items requiring operation, adjustment, or maintenance.
B. Doors and frames shall be of 12-gauge galvanized steel with invisible hinges, and cam lock fastenings. For plaster walls or ceiling, frames shall have a 50 mm. wide lath plaster bond. For masonry walls, the frame shall be set flush with masonry with provisions in the jamb for anchoring. Doors shall be solid flush steel with grey metal primer. Location of access doors shall be coordinated with and shall have the approval of the Engineer before the mechanical work is installed.

2.5 PERMITS
A. The Contractor shall obtain and pay for all necessary permits, inspections and tests, for the proper installation of his work, as may be required by the various administrative authorities having jurisdiction.
B. Certificates of inspections, tests etc., with the proper approval certified thereon, shall be secured by the Contractor and these documents shall be delivered to the Engineer before the work in question will be accepted.

2.6 OPENINGS IN EXTERIOR WALLS
Openings in exterior walls, particularly at or below grade shall be kept properly plugged and caulked at all times, (except when being worked on) to preclude the possibility of flooding due to storms or other causes. After completion of work, openings shall be permanently sealed and caulked in the manner herein specified.

End of Section 23 05 00
SPECIFICATION SECTION 23 05 29
HANGERS AND SUPPORTS FOR HVAC PIPING

TABLE OF CONTENT

PART 1 GENERAL
1.1 Hangers and Supports, Anchors and Guides – General
1.2 Horizontal Piping Support Schedule
PART 1 – GENERAL

Works of this Section shall be governed by Conditions of Contract.

1.1 HANGERS AND SUPPORTS, ANCHORS AND GUIDES - GENERAL

A. Support, anchor and guide all piping to preclude failure or deformation. Construct and install hangers, supports, anchors, guides and accessories to the approval of the Engineer. Do not use wire, tape or metal bands.

B. Fasten piping securely to the structure without overstressing any portion of the supports or the structure itself. Secure pipe supports, anchors and guides to concrete by means of inserts or if greater load carrying capacity is required by means of steel fishplates embedded in the concrete.

C. Un-insulated copper or brass pipe and/or tubing shall be isolated from ferrous hangers or supports.

D. Support piping and tubing at intervals indicated in the schedule hereinafter and at all changes in direction. Maximum deflection shall not exceed 3 mm.

E. Clearance for application of specified Vapour sealed insulation without cutting pipeline covering or fitting covering in installation of pipe hangers and fittings shall be provided.

F. Furnish pipe hangers and supports complete with rods, bolts, lock nuts, swivels, couplings, brackets and all other components and accessories, to allow installation to freely expand and contract.

G. Hangers shall be formed steel clevis type, unless otherwise specified, with adjustable attachment to hanger rod. For copper or brass pipe, use plastic sheathed hangers. Pipe hangers shall fit over vapour sealed insulated piping.

H. Where pipe exceeds maximum loading recommended for clevis type hanger, provide steel pipe clamps.

I. Provide trapeze hangers where several pipes can be installed parallel and at the same level. Trapeze shall be of steel channel sized to support load and drilled for rod hanger at each end. Provision should be made to keep the lines in their relative position to each other by the use of either clamps or clips.

J. For hanger rods on piping 3/8" (10 mm) thru 2" (50 mm) inclusive use 3/8" (10 mm) rods, and for piping 2 ½" (65 mm) thru 5" (125 mm) use 5/8" (16 mm) rods, and for piping 6"(150 mm) thru 12" (300 mm) use 7/8" (22 mm) rods.

K. Wall supports - provide for supporting horizontal piping from wall with steel J-Hook for pipe located close to wall and not larger than 3" (80 mm) pipe. For greater loads, up to 1500 lbs (680 Kg) maximum loading provide welded steel bracket.

L. Pipe-covering (insulation) protection saddles.

M. Provide hanger shields to protect vapor sealed pipe insulation within mechanical equipment rooms at each support point by a 360 degree insert of high density, 100 psi, waterproofed calcium silicate encased in a 120 ° sheet metal shield. Insert thickness shall be same as insulation. Shield length shall equal nominal pipe diameter, minimum but shall not be shorter than 100mm. and need not be longer than 300mm. if bearing load causes no discernable deformation. Insert shall extend 25mm. beyond sheet metal shield. 100mm. shields shall be
26 gauge minimum. Shields 130 to 230mm. long shall be 20 gauge minimum. Shields longer than 230mm shall be 16 gauge.

N. Provide penetration shields to encase insulated pipes penetrating fire walls or floors in a 360°, 24 gauge minimum sheet metal hanger shield with insert of high density, 100 psi. waterproofed calcium silicate the same thickness as insulation and further enclosed within the sleeve, sized for maximum 25mm. spacing between sleeve and insulation shield, pack annular space between sleeve and shield on both ends with double neoprene coated asbestos rope. Install an escutcheon plate to completely cover the wall penetration opening and fit snugly over the pipe insulation shield. Insert shall extend at least 25mm. beyond penetrated surface and escutcheon.

O. Provide oversize hangers with blocking the same thickness as the insulation to pitch vapor sealed insulated pipes accurately at time of insulation.

1.2 Horizontal Piping Support Schedule

A. Steel, Copper and PVC Pipes:
1. ¾" and 1" (20 and 25 mm) steel pipe-----2.5 meter
2. 1 ¼"-2" (32 and 50 mm) steel pipe-------3.0 meter
3. ½"-4" (65 and 100 mm) steel pipe -------4.0 meter
4. 5"-6" (125 and 150 mm) steel pipe--------5.0 meter
5. 8" (200 mm) and above steel pipe -------6.0 meter
6. Up to 1 ¼" (32 mm) copper pipe---------2.0 meter
7. 1 ½" (40 mm) and over copper pipe------3.0 meter
8. ½" (65 mm) and smaller PVC pipe-------1.2 meter
9. 3" (80 mm) and over PVC pipe----------1.8 meter

End of Section 23 05 29
SPECIFICATION SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

TABLE OF CONTENT

PART 1  GENERAL
1.1  General Requirements
1.2  Duct Work
1.3  Balancing and Adjustment
1.4  Controls
1.5  Noise Tests
1.6  Vibration Tests
1.7  Reliability Trial Tests
1.8  Acceptance Tests
1.9  Maintenance During Defects Liability Period and Guarantees.
1.10  Extend Defects Liability and Guarantees.
1.11  Codes and Standards.
1.12  Guarantee and Warranted Period
1.1 GENERAL REQUIREMENTS

A. All equipment shall be tested as specified under the relevant subsection of the specification.

B. Labour, materials, instruments, power etc., required for testing shall be furnished by the Contractor unless otherwise indicated under the particular section of the Specification.

C. Test shall be performed in the presence of representatives of the Engineer and such other parties as may have legal jurisdiction.

D. All defective work shall be promptly repaired or replaced and the tests shall be repeated until the particular system and component parts thereof receive the approval of the Engineer and authorities having jurisdiction, and at no additional cost to the Employer.

E. Any damages resulting from tests shall be repaired and/or damaged materials replaced, all to the satisfaction of the Engineer, and at no additional cost to the Employer.

F. The duration of tests shall be as determined by all parties having jurisdiction, but in no case less than the time prescribed in each subsection of the specification.

G. In the event of any repair or any adjustment having to be made other than normal running adjustment, the test shall be void and shall be repeated after the adjustment or repairs have been made.

H. Three copies of all test results shall be submitted to the Engineer.

1.2 DUCT WORK

A. After completion of duct systems and before insulation is installed, the entire system shall be tested under operating conditions for performance and leakage.

B. Total allowable leakage for low pressure ducts sealed in accordance with SMACNA’s low pressure duct construction standards, shall not exceed five percent (5%) of the system operating air flow.

C. The allowable leakage of medium pressure ducts should not exceed 1% of the total system design air flow rate.

D. All branches and outlets shall be tested for air quantity, and the total of the air quantities shall be within plus five percent (5%) of fan capacity.

E. Volume dampers and splitter dampers shall be tested for proper operation.

F. All fire dampers shall be tested for ease of operation by setting fusible link and applying heat to release link.

1.3 BALANCING AND ADJUSTMENT

A. All air conditioning and ventilation equipment, ductwork and outlets shall be adjusted and balanced to deliver the specified air quantities indicated, at each inlet and outlet, on the Drawings. If these air quantities cannot be delivered without exceeding the speed range of
the sheaves or the available horsepower, the Engineer shall be notified before proceeding with the balancing of air distribution system.

B. Operate the cooling systems and make all adjustments in controls and equipment, and complete necessary balancing to deliver not less than the water quantities required for each coil and equipment.

C. Adjust all equipment to perform with the least possible noise and vibration consistent with its duty. Quietness of operation of all equipment is a requirement. Any piping, ductwork or equipment producing objectionable noise in occupied space must be repaired or replaced with satisfactory one.

D. Operate the air conditioning, ventilating and exhaust systems and make all adjustments in controls and equipment, and complete necessary balancing to deliver within 5% of the air quantities shown on the Drawings at each supply and exhaust outlet.

E. After all adjustments and alterations have been made, a final test shall be conducted. The final test shall include total air volume at fan, maximum and minimum outside and return air volume at extreme damper settings, static pressure at fan outlet, temperature readings indicating output of heating and cooling coils, and RPM of all fans.

1.4 CONTROLS

All controls shall be tested for proper functioning in accordance with the requirements of the Specification.

1.5 NOISE TESTS

A. The Optimum NC/ NR noise levels for Residence, Apartments, Meeting Rooms and Managers Office shall be 30-35 and the contractor shall be responsible to achieve these levels inside the apartments.

B. NC/R Noise Levels for other Room shall be 35 – 40, for Public Toilets shall be 40 – 45 and for MEP Equipment shall be 75 d BLA max (5 min) at 1m from all equipment.

1.6 VIBRATION TESTS

The Optimum vibration levels shall be per BS 6472 Curve 4 for Residence + Apartments and offices, Curve 2 for Meeting Room and Cafeteria and Curve 8 for Public Toilets and MEP Equipment Rooms.

1.7 RELIABILITY TRIAL TESTS

A. After finishing the above tests and adjustments, the Contractor shall be responsible for running a reliability trial test for the whole plant installed.

B. The test data shall not deviate by more than three percent (3%) from the guaranteed capacity data.
C. Should any part of the apparatus or system fail to meet the Contract requirements, it shall be adjusted, repaired or replaced to the satisfaction of the Engineer. The complete performance test shall then be repeated.

D. A ‘Taking Over Certificate’ with or without reservations shall be issued by the Engineer on the satisfactory completion of all the tests, provided that these reservations are of minor importance and will not hinder the satisfactory operation of the Plant.

1.8 ACCEPTANCE TESTS

A. As soon as possible after carrying out the Reliability Trial Test, and during the Maintenance Guarantee Period, the Contractor shall carry out, unless otherwise agreed, the Acceptance Test Specified in the relevant American or British or approved equivalent Standard Specifications, as well as much additional tests at Site, deemed necessary by the Engineer, to determine that the Works comply with the Specifications and provided that the Works are put into operation.

B. The date of commencement of the above said tests shall be subject to agreement with the Engineer.

C. As soon as all tests prescribed in the section are carried out satisfactorily in the opinion of the Engineer, an official statement to that effect (herein referred to as Acceptance Certificate) shall be drawn up in three (3) copies and signed by the Engineer and the Contractor. One copy of the Acceptance Certificate shall be delivered to the Contractor.

1.9 MAINTENANCE DURING DEFECTS LIABILITY PERIOD AND GUARANTEES

A. Starting from the date of issue of the Substantial/Provisional completion certificate the contractor shall be responsible, for the duration of one year, to provide the following services free of charge, at his own cost:-

B. The replacement of parts or whole equipment that show any manufacturing or installation defects during operation.

C. Carry out routine preventive maintenance (fortnightly, monthly, quarterly, half yearly and yearly as applicable to the approval of the Engineer) including provision of labour, parts and supply of consumable materials such as Replaceable air filters, Chemicals for Chilled Water System, Chemicals for Swimming Pool, Lubricants and Refrigerant Gas, required for the safe operation and guarantee of performance of all the systems but not limited to;

1. Split Units
2. Fans
3. Blower Units

D. On call emergency services (24 hours), particularly for elevators, escalators, travellators and fire alarm system.

E. Guarantee of every piece of equipment from any manufacturing or installation defects for a period of one year.
F. At the end of defects liability period the contractor shall be responsible for final handing over of all installed systems in a perfect condition to the satisfaction of both Engineer and client.

1.10 EXTENDED DEFECTS LIABILITY AND GUARANTEES

A. The Contractor shall issue a letter of guarantee for every compressor installed under his contract for a period of five years, starting from the date of issue of the completion certificate. Contractor shall remove the defective compressor and install a new one at his own expense including all necessary accessories and shall do the necessary testing and commissioning. Contractor shall submit a report to the Engineer explaining the reason of damage and methods to prevent it from happening.

B. The Contractor shall issue in favour of the client all original manufacturers extended guarantees as required by specifications or by Engineers approval conditions or by manufacturers initial proposal prior to final handing over to the client.

1.11 CODES AND STANDARDS

A. Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance/manufacturing standards of items mentioned in this section shall confirm to the applicable portions of the latest editions of the following codes, standards and regulations.

<table>
<thead>
<tr>
<th>Reference Code</th>
<th>Abbreviation</th>
<th>Applicable Standard</th>
<th>Title of Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sheet Metal and Air Conditioning Contractors National Association</td>
<td>SMACNA</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>American Society of Mechanical Engineers</td>
<td>ASME</td>
<td>ASME Section Div.1</td>
<td>-</td>
</tr>
</tbody>
</table>

CIBSE – Current Commissioning Codes.
(Series A – Air Distribution Systems-High and Low Velocity,
Series C – Automatic Control System
Series W – Water Distribution System)

1.12 GUARANTEE AND WARRANTED PERIOD

A. All equipment and accessories supplied by the nominated Sub-Contractor under this contract shall be guaranteed for a minimum period of one year from the date of final completion certificate.

B. All guarantee shall be unconditional. In the event of breakdown, the Contractor shall immediately provide and install a replacement unit of equal or superior performance until such time as the original unit is repaired. Failure by the Contractor to comply within 6 hours
of notification, will entitle the Employer to purchase or hire a replacement and seek 
reimbursement from the Contractor for all related disbursements.

C. The Contractor shall guarantee every piece of equipment from any manufacturing or 
installation defects for a period of one year and 5 years for compressors, starting from the 
date of issue of the substantial completion certificate.

End of Section 23 05 93
SPECIFICATION SECTION 23 07 00
HVAC INSULATION

TABLE OF CONTENT

PART 1 GENERAL
1.1 Scope of Work
1.2 Related Works Specified Elsewhere
1.3 Schedule of Insulation Thickness
1.4 Codes and Standards

PART 2 PRODUCTS
2.1 Duct Insulation
2.2 Pipe Insulation - Type A
2.3 Vapour Barrier Coating

PART 3 EXECUTION
3.1 Protection and Cleaning
3.2 Installation of Equipment and Duct Insulation
3.3 Internal Acoustic Liming of Ducts
PART 1 – GENERAL

Works of this Section shall be governed by Conditions of Contract.

1.1 SCOPE OF WORK

A. Supply and install all insulation and lagging on piping, vessels or ducts as indicated on the drawings or specified to be insulated.

B. Canvas jacket and all insulating materials shall be non-combustible, or self-extinguishing non-flame spread grade.

C. Insulation in exposed areas, i.e. permanently visible, shall be protected with aluminum cladding as specified herein after.

1.2 RELATED WORKS SPECIFIED ELSEWHERE

A. All items specified in this section are included in each of following sections, as applicable, as if repeated therein verbatim.

1. Section 23 05 00 - Common Works Results for VAC
2. Section 23 05 29 - Hangers and Supports for VAC Piping
3. Section 23 05 93 - Testing, Adjusting and Balancing for VAC
4. Section 23 21 13 - Pipes and Tubes for VAC
5. Section 23 31 00 - VAC Ducts and Chasings
6. Section 23 33 00 - Air Duct Accessories
7. Section 23 37 00 - Air Outlets and Inlets
8. Section 23 73 00 - Split Units
9. Section 23 74 13 - Packaged, Outdoor, Central Station Air Handling Unit

1.3 SCHEDULE OF INSULATION THICKNESS

The thickness of the insulation applied to pipes, ducts and equipment shall be as stated hereinafter.

<table>
<thead>
<tr>
<th>Service</th>
<th>Location</th>
<th>Pipe Diameter inches (mm)</th>
<th>Thickness inches (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A/C condensate drain pipes</td>
<td>-</td>
<td>-</td>
<td>½ (13)</td>
</tr>
<tr>
<td>supply and return air ducts</td>
<td>In conditioned</td>
<td>-</td>
<td>1 ¼” (38)</td>
</tr>
</tbody>
</table>
spaces

<table>
<thead>
<tr>
<th>Untreated fresh air duct</th>
<th>passing through air plenum</th>
<th>-</th>
<th>1 (25)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diesel Engine Exhaust</td>
<td>-</td>
<td>-</td>
<td>1 ½ (38)</td>
</tr>
</tbody>
</table>

### 1.4 CODES AND STANDARDS

A. Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance/manufacturing standards of items mentioned in this section shall confirm to the applicable portions of the latest editions of the following codes, standards and regulations.

<table>
<thead>
<tr>
<th>Reference Code</th>
<th>Abbreviation</th>
<th>Applicable Standard</th>
<th>Title of Standard</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>NFPA 90B</td>
<td>Standard for warm Air Heating and Air Conditioning Systems.</td>
</tr>
</tbody>
</table>
PART 2 – PRODUCTS

2.1 DUCT INSULATION
A. Duct insulation in air-conditioned spaces shall be blankets of fibrous glass with a density of not less than 1.5 lb/ft³ (24 kg/m³) and a K-factor of not more than 0.26 Btu-in/ft² hr. deg. F (0.038 W/m deg. K) at a mean temperature of 75 deg. F (24 deg C) for concealed insulation.

B. For cold air application, insulation shall be faced with factory applied reinforced foil and paper which comprises aluminium foil reinforced with fiberglass yarn mesh and laminated to 40 lbs chemically treated fire retardant kraft.

C. 50 x 50 x 0.6 mm galvanised sheet metal angles shall be attached at corners.

2.2 PIPE INSULATION - TYPE A
A. This type of insulation shall apply to refrigerant pipes and A/C condensate drain pipes.

B. Insulation shall be flexible foamed closed cell elastomeric tubular form type. Insulation may be slipped over pipe or tubing before pipe connections are made, or may be slit longitudinally and snapped onto the pipe and then sealed with vapour barrier adhesive.

C. Insulation shall have a thermal conductivity not greater than 0.27 BTU / Hr °F. ft sq. per inch thickness at a mean temperature of 75 ° F.

D. The surface finish shall be an 8-ounce canvas cloth embedded between 2 coats of vapour barrier. Aluminium cladding shall be provided as specified.

2.3 VAPOUR BARRIER COATING
A. The vapour barrier coating shall be tough flexible fire resistive elastomeric finish for protection of thermal insulation. It shall meet the requirements of NFPA 90A and 90B and shall be UL classified.

B. The vapour barrier shall have water vapour permeability not more than 0.02 perms at 0.75 mm dry film thickness when tested to ASTM E96 Method.

C. When tested for surface burning characteristics (ASTM E84) it shall have a flame spread rating not exceeding 10 and smoke developed not higher than 15.

D. The vapour barrier shall be suitable for application by brush or spray. It shall be applied in 2 coats with heavy duty fire retardant canvas cloth (8 ounce) embedded between the coats. Canvas overlap at joints shall be at least 50 mm. The wet film thickness of each coat shall be at least 1.25 mm.

E. Vapour barrier coating shall be applied above thermal insulation of refrigeration and condensate drain pipes.
PART 3 – EXECUTION

3.1 PROTECTION AND CLEANING

A. All insulation shall have a smooth, homogenous and lineable finished surface. All rigid sections shall be concentric and be accurately matched for thickness.

B. All surfaces to be insulated shall be dry and free from loose scale, dirt, oil or water when insulation is applied.

C. Insulation shall be applied in such a manner that air circulation within the insulation or between the insulation and the pipe shall be avoided.

D. No surface imperfections in the insulation such as damaged edges, or ends, cracks and small voids or holes shall be accepted.

E. Insulation materials shall be stored and protected from weather moisture, accumulations of foreign matter, or possible damage in a dry and clean store.

F. Surface finishes and lagging adhesives shall not be diluted and shall be applied in accordance with the manufacturer’s instructions.

G. Apply insulation to permit expansion or contraction of metal without causing damage to insulation or surface finish.

3.1 INSTALLATION OF DUCT

A. Insulated ducts penetrating walls or floors shall be insulated completely thru penetration. Provide waterproof calcium silicate insert, same thickness and jacketing as insulation with wall flange for fire wall or floor penetrations, or as detailed on the Drawings.

B. Duct insulation or lining or any type of covering together with the applied adhesives shall have a flame spread rating not over 25 without evidence of continued progressive combustion and a smoke developed rating no higher than 50, wherever the duct crosses a fire wall or penetrates a roof slab.

C. Duct linings shall be interrupted at fire dampers and fire doors so as not to interfere with the operation of services.

D. All duct materials and coverings (insulation, pre-insulated panels, linings, etc.) shall meet the requirements of NFPA 90A and 90B Standards or equivalent European Standards.

E. Adhesives, sealants, vapour barriers, paints, etc., shall meet the requirements of NFPA 90A and 90B and shall be UL Classified.

3.2 INTERNAL ACOUSTIC LINING OF DUCTS

A. Where the specialist acoustic engineer agrees that it is possible to achieve the required attenuation, by employing acoustic lining to the interior surfaces of the ductwork. This may be done by applying the thickness of acoustic lining recommended by the acoustic engineer and backed up by detailed acoustic analysis which indicated also the length of ductwork to be acoustically lined.
B. The acoustic lining for rectangular ducts, semi-rigid fibrous glass blanket having a minimum density of 49 kg/m³ and special surface treatment to prevent erosion of the fibrous materials. This surface treatment should include, but not be limited to providing a woven glass fibre scrim facia bonded to the fibre glass with an non-flammable, water based adhesive, the lateral and longitudinal material joints shall be sealed using a “pre-stick” woven fiberglass bandage. The acoustic lining should be abrasion proof for air velocities up to 15 m/sec.

C. For grease laden or saturated atmosphere applications the acoustic fiberglass type lining material should be protected by a “Melanex” moisture repellent with 22 gauge galvanised perforated sheet steel protective facia.

D. The acoustic insulation shall be suited to the atmosphere in which it is to operate and shall be incombustible or self-extinguishing non-flame spread grade and shall have a density of 28 kg/m³ for polyurethane foams or 48 kg/m³ for fiberglass liner and shall comply with I.S.O. requirements.

E. Isolation hangers shall be used for suspended pipes and equipment.

F. Isolation hangers are rubber or springs or a combination of both.

G. Rubber Hangers
   1. Shall be of the rubber-in-shear type. It shall consist of:
      a) A high grade rubber block with suspension rod and an outside steel housing.
      b) The steel housing will be anchored to the ceiling slab and the suspension rod shall support the equipment.
      c) The rubber shall be protected against corrosion due to oil or other damaging agents.

H. Spring Hangers
   Shall be of the open mounting type and shall consist of a steel spring between a top and bottom plate with an adjustment bolt or levelling.

   The spring should be designed to provide horizontal stiffness at least 75% of vertical stiffness to assure stability, 50% travel beyond rated load and safe solid stresses.
SPECIFICATION SECTION 23 23 00
REFRIGERANT PIPING

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3.5 Pipe Sleeves
3.6 Cleaning of Piping Systems
1.1 INTRODUCTION
A. Works of this Section shall be governed by Conditions of Contract and Division – A requirements.
B. This section describes basics materials and requirements for Pipework services installations for building.

1.2 RELATED WORKS SPECIFIED ELSEWHERE
A. Common Works Results for HVAC
B. Hangers and Supports for HVAC Piping
C. Mechanical Identification for HVAC Piping
D. Testing, Adjusting and Balancing for HVAC
E. HVAC Insulation
F. HVAC Ducts and Chasings
G. Air Duct Accessories
H. Air Outlets and Inlets
I. Mini Split A/C Units
J. Packaged, Outdoor, Central Station Air Handling Units

1.3 PIPE IDENTIFICATION
A. All pipes shall be indelibly marked at intervals of not greater than 3m. The marking shall show the manufacturer's identification, the standard name and number, and the nominal size and class. Adhesive labels alone shall not suffice. All pipes complying with British Standards shall be kitemarked.

1.4 CODES AND STANDARDS
A. Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance/manufacturing standards of items mentioned in this section shall confirm to the applicable portions of the latest editions of the following codes, standards and regulations.
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<td>Specification for seamless copper tube for A/C and refrigeration field service.</td>
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<td>ASTM A307</td>
<td>Specification for Carbon Steel Bolts and Studs. 60,000psi tensile strength</td>
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<td>ASTM D1785</td>
<td>Specification for poly (vinyl chloride) (PVC) plastic pipe, schedules 40, 80,</td>
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<td>BS 4346 Part 2</td>
<td>Mechanic joints and fittings, principally of unplasticized PVC.</td>
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<td>Specification for unplasticized PVC pipe and fittings for gravity sewers.</td>
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<td>BS 2871</td>
<td>Specification for copper and copper alloys, tubes.</td>
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<td>BS 864 Part 2</td>
<td>Specification for capillary and compression fittings for copper tubes.</td>
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<tr>
<td>BS 3601</td>
<td>Specification for carbon steel pipes and tubes with specified room temperature properties for pressure pipes.</td>
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<td>BS 21</td>
<td>Specification for pipe threads for tubes and fittings where pressure tight joints are made on the threads.</td>
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</table>
2.1 **COPPER PIPES-CUP-TYPE 3**

A. Copper pipes shall be of the seamless hard drawn tubing type K or L to ASTM B 280-88. Tubing, to be used, shall have been cleaned by the manufacturer and the open ends capped to preserve cleanliness.

B. Cup shall be designed, constructed and installed in compliance with ASA B9.1 and ASA B35.5 (safety code for Mechanical Refrigeration).

C. CuP shall be suitable for solder jointing with forged or wrought copper fittings.

D. Cast fittings should not be used because they might be porous and allow the refrigerant to leak.

E. Surfaces to be soldered shall be cleaned bright. The joints shall be given a thin coating of approved soldering flux and the tubing end inserted into the fitting as far as possible.

F. Heating and finishing of the joint shall be done in accordance with the recommendations of the manufacturer of the fittings. During the heating, the pipe and fittings must be kept full of an inert gas N or CO2 to prevent formation of scale.

G. The solder metal to be used shall be a non-ferrous metal or alloy having a melting point below 800 °F (427 °C) and below that of the metal being joined, an accepted solder is Sil-Fos to make copper to copper joints.

H. When solenoid valves are being installed, the coil should be removed, and no heat shall be applied near the bulb of the expansion valve.

I. CuP type 3 are allowed to be used to carry refrigerants 12, 22 and 500 only and/or as specifically mentioned in the schedule of pipe materials.

2.2 **UPVC Pipes Type 1**

A. Polyvinyl chloride pipes (PVC) shall be of the un-plasticized rigid type and of high density and complete homogeneity material.

B. UPVC Pipes - Type 1 shall comply with BS EN 1329-1: 2000 specification for pipes, fittings and the system.

C. UPVC Pipes - Type 1 piping systems shall be used in the field of A/C condensate drain.

D. UPVC Pipes Type 1 piping systems sockets and spigots shall be either for solvent cement joints or ring seal joints.

2.3 **FLANGED PIPE JOINTS**

A. All flanged joints shall be made up with compressed ring type asbestos gaskets. Gaskets shall be 1.5 mm. thick.
B. Bolts for flanges shall be of low carbon steel with hexagonal heads and hard pressed steel hexagon nuts. Bolts shall be to ASTM specifications A 307 or SAE grade 2, with tensile strength of 64000 psi (441.3 Mpa) minimum.

C. All bolt holes shall be spot faced.

2.4 JOINTS BETWEEN DISSIMILAR METALS (DIELECTRIC ISOLATORS)

A. Make joints between ferrous and non-ferrous screwed piping and equipment by using Teflon or nylon isolating materials in the form of screwed unions.

B. Make joints between ferrous and non-ferrous flanged piping and equipment with insulating gaskets and "Teflon sleeves and washers between flanges, bolts and nuts.

C. The entire insulating joint including the dielectric material shall be suitable to withstand the temperature, pressure and other operating characteristics for the service for which they are used.

2.5 PIPING SCHEDULE

A. General

a. Piping classes are specified for each service in the following schedule. The designations indicated refer to detailed specifications for piping in this section of the specifications:

B. Piping Classes

   Service Piping Class

   1. A/C Condensate drains UPVC Type 1

   2. A/C Condensate drain above false ceiling, UPVC Type 1

   3. Refrigerant Pipes CUP-3
PART 3 – EXECUTION

3.1 ARRANGEMENT AND ALIGNMENT OF PIPES
A. Install piping in a neat, workmanlike manner and the various lines shall be parallel to building walls wherever possible.
B. Install refrigerant pipe groups in parallel with each other.

3.2 GENERAL REQUIREMENTS FOR PIPING INSTALLATION
A. Make all changes in size and direction of piping with standard fittings.
B. Make all branch connections with tees.
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. Pipes and fittings shall both be manufactured according to one single standard unit of measurement, either both English or both metric.

3.3 CONNECTION TO EQUIPMENT AND CONTROL VALVES
A. Provide flanges or unions at all final connections to equipment and control valves to facilitate dismantling. Arrange connections so that the equipment being served may be removed without disturbing the piping.

3.4 INSTALLATION OF UNIONS AND FLANGES
A. Unions and flanges shall be installed at all equipment inlets and outlets,

3.5 PIPE SLEEVES
A. Provide all pipe openings through walls, partitions and slabs with sleeves having an internal diameter at least 50mm larger than the outside diameter of the pipe for un-insulated lines or of the insulation for insulated pipes.
B. Install sleeves through interior walls and partitions flush with finished surfaces; sleeves through outside walls to project 15mm. on each side of the finished wall; and floor sleeves to project 25mm. above finished floors.
C. Set sleeves in place before pouring concrete or securely fasten and grout in with cement.
D. Sleeve construction:
   1. Interior Partitions - galvanized sheet iron.
   2. Interior & Exterior Masonry Walls and Floors-galvanized steel pipe.
E. Fill the space between outside of pipe or insulation and the inside of the sleeve or framed opening with fibrous asbestos in interior walls and floors and pack with oakum, seal with watertight mastic or asphalt in exterior walls.

3.6 CLEANING OF PIPING SYSTEMS

A. Plug all opening ends of piping, valves and equipment except when actual work is being performed to minimize accumulation of dirt and debris.

End of Section 23 23 00
### SPECIFICATION SECTION 23 31 00

#### HVAC DUCTS WORK

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PART 1 – GENERAL

1.1 INTRODUCTION
This section includes the design, supply, installation testing and commissioning of complete ductwork system for air conditioning fresh air, exhaust and ventilation systems.

1.2 SCOPE OF WORK
The contractor shall be responsible for submitting complete above works based on design consultant’s approval of submitted samples, documents etc as per specifications and applicable standards.

1.3 RELATED WORKS SPECIFIED ELSEWHERE
A. Section 23 05 00 - Common Works Results for VAC
B. Section 23 05 29 - Hangers and Supports for VAC Piping
C. Section 23 05 53 - Mechanical Identification for VAC Piping
D. Section 23 05 93 - Testing, Adjusting and Balancing for VAC
E. Section 23 07 00 - VAC Insulation
F. Section 23 21 13 - Pipes and Tubes for VAC
G. Section 23 33 00 - Air Duct Accessories
H. Section 23 37 00 - Air Outlets and Inlets
I. Section 23 81 26 - Split -System Air-Conditioners
J. Section 23 74 13 - Packaged, Outdoor, Central Station Air Handling Units

1.4 REFERENCE STANDARDS

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<tr>
<td>NFPA 90A</td>
<td>Standard for the installation of air conditioning and ventilating systems</td>
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<td>SMACNA</td>
<td>Sheet Metal and air conditioning contractors national association</td>
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<td>ASHRAE</td>
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<td>UL 181</td>
<td>Underwriters laboratories</td>
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<tr>
<td>ASTM A653-99</td>
<td>Specification for steel sheet, Zinc-coated (Galvanized) by the Hot-Dip process.</td>
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PART 2 – PRODUCTS

2.1 DUCTWORK
A. Galvanised sheet steel ducts shall be of G90 coating designation within ASTM A653-99, standard specification for ‘steel sheet zinc coated by the hot dip process’. The weight of coating on both sides of duct shall be 0.9 oz/ft² (275g/m²) as a minimum check limit triple spot test.
B. The ducts’ gauges, thickness, type and method or jointing shall be as detailed and tabulated on the Drawings and/or in compliance with ASHRAE Standards and Handbooks.

2.2 DUCT HANGERS AND SUPPORT
A. Supply and install steel work necessary for the support of the ductwork. Hangers shall be spaced not more than 3000 mm. apart, and at changes of direction. Types and construction of hangers shall be as detailed on the Drawings and in compliance with SMACNA recommendations.

2.3 FLEXIBLE DUCTS
A. Ducts shall be all metal constructed of heavy gauge corrugated aluminum with water tight continuous lock seams.
B. Ducts shall be UL 181 Class O non-combustible and complying with NFPA 90A & 90B, or tested to BS 476 (parts 6, 7 & 20) class 1 flame spread and meets the requirements of CP 413 section A2.2.3.
C. For air conditioning flexible ducts shall have 25mm thick fiber glass insulation and sheathed in durable polymer vapour barrier.
PART 3 – EXECUTION

3.1 DUCT CONSTRUCTION

A. All ducts shall be constructed and erected so as to be rigid and free from sway, drumming and movement. Duct work shall be true to sizes indicated on Drawings, straight and smooth on the inside with neatly finished joints. Whenever internal acoustic lining is indicated on the Drawings, the duct sizes have to be increased to accommodate the lining.

B. Ductwork joints shall be square with all sharp edges removed.

C. The ducts shall be routed with a minimum of directional changes and abrupt transitions.

D. Adequate space shall be provided around ducts to assure proper support and to allow the installation of the specified insulation.

E. All connections between ductwork, including flexible connections, fittings and equipment, shall be made with gradually tapered transition fittings.

F. Whenever a flexible duct is used to correct misalignment between the supply duct and the diffuser ceiling location, the misalignment (or offset) shall not exceed one-eighth (1/8) the length of the collar (or diffuser diameter). Flexible duct length shall not exceed 30 cm.

G. Changes in section of ductwork shall be effected by tempering in ducts with as long a taper as possible. All branches shall be taken off at not more than 45 degree angle from the axis of the main duct unless otherwise approved by the Engineer.

H. The ducts shall be securely anchored to the building in an approved manner.

I. The ducts shall be installed as to be completely free from vibration under all conditions of operation.

J. The ducts and hangers shall be installed straight, plumb and level.

K. Wherever ducts pass thru walls or floors, a sleeve of galvanized mild steel sheet shall be provided and the space between the pre-insulated duct and the sleeve shall be caulked with lead wool and finished on each face with a mastic fill.

L. All slip joints shall be made in the direction of flow.

M. All elbows shall have a centerline radius equal to at least 1.5 times the width of the duct, otherwise turning vanes shall be installed in the elbows.

N. Adjustable splitters and hinged volume dampers shall be provided at every duct junction on both supply and exhaust ductwork for adjusting air volumes.

O. Where splitters and dampers are installed above suspended ceiling, flush-mounted controlling devices shall be used.

P. Connection to diffusers, grilles and registers shall be made absolutely airtight.

Q. Equalizing grids or turning vanes shall be installed ahead of an air outlet whenever poor approach conditions, from the main duct to the outlet, exist.

R. In critical low noise level projects, poor approach conditions are not allowed.

S. Where the duct is pierced for any reason, sealing compound shall be used.

T. All joints and fittings concealed in vertical duct shafts shall be welded.
3.2 PROTECTION AND CLEANING

A. During construction, cover all open ends of ductwork with one layer of canvas.
B. Remove all foreign materials and clean the duct inside and outside.
C. Clean ducts before operating fans and filters. Never operate fans unless filters are installed.
D. Operate the fans and thoroughly blow out the interior surfaces of the duct work.
E. After tests, wash cleanable filters and replace renewable media.

3.3 Access Openings in Insulated Ducts

Where ducts require to be thermally insulated the door frame shall be extended beyond the face of the duct by a measurement equal to the thickness of the insulation and as arranged so that the insulation can be 'dressed' into the frame. Doors or covers shall be suitably insulated and provisions made to ensure that the seal is continuous across the whole opening. The extent of the opening shall be clearly visible or otherwise indicated. Where it is impossible to vapour seal an access opening, provision shall be made for collecting and draining condensation.

End of Section 23 31 00
SPECIFICATION SECTION 23 33 00
AIR DUCTS ACCESSORIES

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PART 1 – GENERAL

1.1 INTRODUCTION
This section includes the design, supply, installation testing and commissioning of all materials for the complete installation of air distribution specialties and duct accessories for the air distribution system.

1.2 SCOPE OF WORK
The contractor shall be responsible for submitting complete above works based on design consultant’s approval of submitted samples, documents etc as per specifications and applicable standards.

1.3 RELATED WORKS SPECIFIED ELSEWHERE
A. Section 23 05 00 - Common Works Results for VAC
B. Section 23 05 29 - Hangers and Supports for VAC Piping
C. Section 23 05 53 - Mechanical Identification for VAC Piping
D. Section 23 05 93 - Testing, Adjusting and Balancing for VAC
E. Section 23 07 00 - VAC Insulation
F. Section 23 21 13 - Pipes and Tubes for VAC
G. Section 23 31 00 - VAC Ducts and Chasings
H. Section 23 37 00 - Air Outlets and Inlets
I. Section 23 81 26 - Split -System Air-Conditioners
J. Section 23 74 13 - Packaged, Outdoor, Central Station Air Handling Units

1.4 REFERENCE STANDARDS
UL 555 Standard for fire Dampers and ceiling dampers
NFPA 90A Standard for the installation of air conditioning and ventilating systems.
ASTM – A525 Specification for general requirements for steel sheet, zinc-coated (galvanized), by the Hot-dip process.
BS 5588-Part 9 Code of Practice for air-conditioning and ventilation duct work
PART 2 – PRODUCTS

2.1 VOLUME CONTROL DAMPERS

A. Volume control dampers shall be complete with locking levers and quadrants, indicating their position.

B. Volume dampers shall be provided whether shown/or not on drawings in main ducts, in all branch ducts supplying three (3) or more air outlets, etc to achieve proper system balancing.

C. Upon completion of the ductwork, dampers shall be adjusted and set to deliver the amounts of air indicated on the Drawings.

2.2 GRAVITY DAMPERS

A. Gravity dampers shall consist of:
   2. Aluminum blades.
   3. Stainless steel bearing shafts and brass bearings.
   4. Neoprene seal to withstand 120 °C. air temperature.
   5. Aluminum blade travel stop.

B. All blades shall be coupled together by means of an aluminum bar.

2.3 FLEXIBLE CONNECTIONS

A. Flexible connections of approved flame retardant fabric to prevent the transmission of vibration through the ducts shall be installed on both the supply and return sides of all fans and ventilating units for a maximum length of 250mm. and a minimum of 100mm. in the direction of the flow. The fabric shall have a flame spread rating of not over 25 and a smoke developed rating of not higher than 50.

B. Flexible connections shall connect ducts across structural expansion joints.

C. Cloth used for flexible connections shall be of proper weight and strength for the service required, and shall be properly fitted to render it relatively tight.

D. Neoprene laminated fabric, with neoprene facing on interior surface, shall be used for ducts handling other than clean dry air.

E. Flexible duct connection used for air conditioning, air handling units shall have vinyl coated fabric insulated with 1" (25 mm) fiberglass insulation of 0.75 lbs/ft³ (12 Kg/m³) minimum density, designed to NFPA-90 or BS 5588 part 9 Standards. The connector should be pre-assembled metal to fabric.

F. The connector shall be 24 gauge galvanized zinc to ASTM-A525 G 60.

2.4 INTERNAL ACOUSTIC LINING OF DUCTS

(Refer to Section 23 07 00 : HVAC Insulation)
PART 3 – EXECUTION

3.1 ACCESS OPENINGS

A. General:

All access openings shall be rigidly framed and made air-tight. Covers shall be simply and speedily removed and re-fixed. Multiple set screws or self-tapping screws will not be acceptable as a method of fixing. Access doors and other openings in ductwork shall be provided for the purposes given below. The number, size and locations shall be as indicated on the Drawings or as necessary to ensure adequate access to equipment and plant.

B. Access for Maintenance, Cleaning and Inspection:

Inspection openings shall generally not be larger than 300mm high by 400mm wide unless essential for access to equipment, in which case the size shall be agreed before manufacture. The opening in the duct shall be adequately stiffened and the door cover sufficiently rigid to prevent distortion. Approved sealing gaskets and suitable fastenings shall be provided to ensure air-tight sealing.

C. Access Openings in Insulated Ducts:

Where ducts require to be thermally insulated the door frame shall be extended beyond the face of the duct by a measurement equal to the thickness of the insulation and as arranged so that the insulation can be ‘dressed’ into the frame. Doors or covers shall be suitably insulated and provisions made to ensure that the seal is continuous across the whole opening. The extent of the opening shall be clearly visible or otherwise indicated. Where it is impossible to vapour seal an access opening, provision shall be made for collecting and draining condensation.

End of Section 23 33 00
### SPECIFICATION SECTION 23 37 00

**AIR OUTLETS AND INLETS**

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PART 1 – GENERAL

1.1 INTRODUCTION

This section of specification includes the design, supply, installation testing and commissioning of the Air inlets and outlets for the complete air conditioning and ventilating system including, etc.

1.2 SCOPE OF WORK

The contractor shall be responsible for submitting complete above works based on design consultant’s approval of samples, submitted documents etc as per specifications and applicable standards.

1.3 RELATED WORKS SPECIFIED ELSEWHERE

a. Common Works Results for HVAC
b. Hangers and Supports for HVAC Piping
c. Testing, Adjusting and Balancing for HVAC
d. HVAC Insulation
e. Pipes and Tubes for HVAC
f. HVAC Ducts and Chasings
g. Air Duct Accessories
h. HVAC Fan
i. Split -System Air-Conditioners
j. Packaged, Outdoor, Central Station Air Handling Units

1.4 REFERENCE STANDARDS

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<tr>
<td>DW 142</td>
<td>British Heating &amp; Ventilating Contractors association Code of Practice</td>
</tr>
<tr>
<td>NFPA 90A</td>
<td>Standard for the installation of air conditioning and ventilating systems</td>
</tr>
<tr>
<td>ADC</td>
<td>Air diffusion council</td>
</tr>
</tbody>
</table>

1.5 AIR DISTRIBUTION OUTLETS GENERAL REQUIREMENTS

A. All air outlets shall be of, at least the sizes indicated on the Drawings. Irrespective of the sizes indicated on drawings, diffusers/grillers shall be sized such that the noise spectrum of the supply outlets not higher than NC-25 but in all cases outlet selected shall perform within
the noise level requirement of the space it is supplying. Outlets shall be supplied with foam rubber gaskets to prevent air leakage.

B. Where supply or return outlets are installed in continuous line, omit intermediate frames and margins. Provide guides for each element to keep adjoining lengths aligned and butted without breaks. All outlets shall be constructed of aluminum of the color specified or as selected by the Engineer.

C. Outlets causing excessive air movement, drafts or objectionable noise shall be replaced at no cost to the owner.

D. All outlets shall be powder coated, samples showing finish and color shall be submitted to the Engineer for approval prior to supplying the outlets to Site.

E. The Contractor shall provide in his Tender for delaying the fixing of loose grilles until all other trades have completed their work, returning to the Site to fit the grilles as and when required to do so.
PART 2 – PRODUCTS

2.1 AIR DIFFUSERS - SQUARE

A. Air diffusers shall be of the diffusion and air mixing type and shall be made of anodized aluminum.
B. Supplied air shall be diffused with no air velocities in excess of 50 fpm. (0.25 m/s) at 1800 mm height or less above the floor line. Room air shall be mixed with the primary air by induction to effect subsequent uniformity of the room temperature without stratification.
C. Each diffuser shall be provided with an aluminum opposed blade damper.
D. Diffuser shall not project appreciably below ceiling or duct.
E. The inner assembly of the diffusers shall be attached to the outer assembly by means of a lock permitting assembly and disassembly without the use of tools.
F. The noise level shall be measured at a point one meter below the diffuser.

2.2 PERFORATED CEILING DIFFUSER (LAMINAR FLOW CEILING)

A. Supply and install "Laminar Flow panel" of the perforated type suitable for operating theatre applications.
B. Laminar-floor panels shall consist of a faceplate of perforated epoxy paint (Aseptic Pain) stainless steel, a mounting frame of aluminium extrusion, and a stainless steel plenum chamber complete with a supply spigot. Volume control dampers should be fitted in the upstream ductwork to avoid noise generation.
C. Plenum chambers shall be mounted on the back of the perforated faceplate, and forms a complete individual unit.
D. In the case of a multi-panel unit, the plenums shall be formed by enclosing the back of the frames with a panel having a separate spigot to each sub-unit.
E. Fixing shall be done on recessed mounting frame with an aperture for access to screw from inside the plenum box. The aperture shall be sealed after fixing.

2.3 FRESH AIR AND DISCHARGE LOUVERS

A. Louvers for fresh air intake, and for exhaust. They shall be white anodized aluminum.
B. Louvers shall be weatherproof, with fixed blades set at 30 degree and shall have a free area of 85%.
C. Louvers shall be furnished with ½” (13mm) mesh-bird screen secured in removable extruded Aluminum frames.

2.4 SAND TRAP LOUVERS

A. Sand trap louver shall have a high degree of separation of sand and large dust particles, even in cases of high dust concentrations. The vertically arranged sections and holes for sand drainage shall ensure the sand trap louver is self-cleaning and maintenance free. The
sand trap louver shall be designed to separate large particles at low air velocities, thus avoiding excessive dust loading.

B. The sand trap louver shall be constructed in polyester powder coated aluminum, and shall be complete with transom, sand chute and galvanized bird screen. Color shall be to Engineer’s approval.

C. Whether shown on drawings or not, all fresh air intakes shall be with sand trap louvers, filters and volume control dampers.

2.5 DOOR LOUVERS
A. The door louvers shall be sized so that the face velocity does not exceed 250 fpm (1.3 m/s) unless otherwise indicated on the Drawings.

B. The louver shall be extruded aluminum completely lightproof V-Section with double frame.
PART 3 – EXECUTION

3.1 INSTALLATION

All outlets shall be erected square and level and accurately set in position, to ensure symmetry with other grilles, light fittings, etc. It has been arranged that final minor adjustments to suspension levels to obtain final accurate alignment between the ceiling and light fittings, diffusers, etc., shall be executed by those responsible for erecting the false ceilings.

3.2 FIXING

All outlets shall be concealed fixing type with no screws.

3.3 REJECTED

Any imperfect outlet scratched or damaged surfaces of fixing screws having damaged heads, or scratched plating, will be rejected and shall be replaced satisfactorily before the Contract Works will be taken over as complete.

END OF SECTION 23 37 00
SPECIFICATION SECTION 23 81 26
SPLIT SYSTEM AIR CONDITIONERS

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1.2 Related Works Specified Elsewhere
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1.4 Design Conditions

PART 2 PRODUCTS
2.1 Mini Split System
2.2 Split System
2.3 Guarantee and Warranted Period
PART 1 – GENERAL

1.1 SCOPE OF WORK
   A. The works covered under this Section shall include all the supply, installation, testing and delivery in good operating conditions of a complete Mini-Split Units as described, shown detailed or implied in the tender documents of the project.
   
   B. The Contractor shall provide all the necessary components and accessories as well as manpower, scaffolding, painting, testing facilities, etc... at his own expense to execute a complete operable system.
   
   C. The Contractor shall program his work such that it will not interfere with other trades and to suit site requirements.

1.2 RELATED WORKS SPECIFIED ELSEWHERE
   A. The works specified in the following sections are included in this Section in each applicable part, as if repeated herein verbatim.
   1. Section 23 05 00 - Common Works Results for VAC
   2. Section 23 05 29 - Hangers and Supports for VAC Piping
   3. Section 23 05 53 - Mechanical Identification for VAC Piping
   4. Section 23 05 93 - Testing, Adjusting and Balancing for VAC
   5. Section 23 07 00 - VAC Insulation
   6. Section 23 21 13 - Pipes and Tubes for VAC
   7. Section 23 31 00 - VAC Ducts and Chasings
   8. Section 23 33 00 - Air Duct Accessories
   9. Section 23 34 00 - VAC Fan
   10. Section 23 37 00 - Air Outlets and Inlets
   11. Section 23 74 13 - Packaged, Outdoor, Central Station Air Handling Units

1.3 CODES AND STANDARDS
   A. Codes and standards applicable to this section shall be primarily British Standards and United States Codes, unless otherwise specified, the performance/manufacturing standards of items mentioned in this section shall confirm to the applicable portions of the latest editions of the following codes, standards and regulations.

<table>
<thead>
<tr>
<th>Reference Code</th>
<th>Abbreviation</th>
<th>Applicable Standard</th>
<th>Title of Standard</th>
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<tr>
<td>American Society of Heating Refrigerating and Air Conditioning Engineers.</td>
<td>ASHRAE</td>
<td>-</td>
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<tr>
<td>National Electrical</td>
<td>NEMA</td>
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1.4 DESIGN CONDITIONS

A. The air conditioning system is based on the following design conditions.
   1. Outside summer conditions:
      2. 46° C Dry Bulb.
      3. 21° C Wet Bulb.
      4. 16.5° C Daily range.

B. The inside summer conditions are indicated on the Drawings in the units capacity schedules.

<table>
<thead>
<tr>
<th>Manufacturers Association</th>
<th>National Electrical Code</th>
<th>Air Moving and Conditioning Associations</th>
<th>National Fire Protection Association</th>
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<tr>
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American Refrigeration Institute.
2.1 MINI-SPLIT SYSTEM

A. Mini split system shall cover a range up to three tons of refrigeration and shall consist of a condensing unit, an evaporator blower unit, and refrigerant piping network between the blower coil and the condensing unit, reverse cycle for heating and cooling.

B. Condensing Unit:
   1. Condensing unit shall be of the air cooled type completely assembled at the factory and shall consist of the following:
      a) Phosphatized zinc coated steel casing.
      b) Reverse Cycle for heating and cooling
      c) Hermetic Compressor.
      d) Air cooled condenser and condenser fan.
      e) All necessary controls and accessories for automatic and proper operation.

C. Evaporator Blower Unit
   1. The evaporator blower unit shall be installed indoors and shall be of the type indicated on the Drawings.
   2. The unit shall be complete with:
      a) Evaporator cooling unit.
      b) Centrifugal 3-speed blower and blower motor.
      c) Cleanable filter.
      d) Remote thermostat, thermometer, speed selector switch and time control.
      e) Decorative cabinet if installed exposed.
      f) Electric heating element (if shown on Drawing).

2.2 SPLIT SYSTEMS

A. Each split system shall consist of two major components, one condensing unit installed outdoor and one blower coil unit installed indoor. Both units are interconnected with copper pipes.

B. Each system shall be supplied complete with all necessary control wiring for its proper operation.

C. Condensing Units:
   1. General: Supply and install wherever shown on the Drawings condensing units of the direct expansion air-cooled type. Unit shall be factory-assembled into a compact, weather-proof cabinet with common base size. Each condensing unit shall be complete with casing, compressor, condenser, reverse cycle for heating and cooling control panel, one main
disconnect switch, vibration isolators and all electrical power and control wiring necessary for proper operation.

Unit shall provide heating and cooling for the same space.

2. Casing: Casing shall be at least 18 gauge, zinc-coated steel, phosphatized and painted externally with epoxy resin primer and finished with an approved top coat. Casing shall have a removable end panel, to allow for access to all components and connections, and die formed mounting rails integrated with unit base. Casing shall be provided with drainage holes in the base pan.

3. Compressor: Compressor shall be of the hermetic, reciprocating direct drive type with crank case heater, discharge line sound muffler and suction and discharge valves. Compressor shall have internal protection devices to provide protection for motor overload, locked rotor, and excessive winding temperatures.

4. Condenser Coil and Fans:
   a) Coil shall be of the seamless copper tubes with heavy aluminium fins mechanically bonded to the tubes, coil shall be factory pressure and leak tested at not less than 400 psig (2756 Kpa) air pressure. Condenser coil shall be protected by heavy-duty grille.
   b) Condenser fans shall be statically and dynamically balanced of aerodynamic design, heavy duty motors. Each motor shall have built-in current and thermal overload protection and permanently lubricated ball bearings. Fan motor shall be provided with short circuit protective device(s).
   c) Propeller Type Fans: shall be of the direct drive type with fan motor support mounted to cabinet top. Fan shall have rugged steel guards for protection.
   d) Centrifugal Type Fan: shall be of the double inlet forward- curved blades, belt driven with adjustable pulleys. Fan motor shall be capable to overcome specified static pressure.
   e) Control panel: Condensing unit shall be equipped with a factory wired built-in control panel comprising: 24-volts control power transformer, magnetic contactors for compressor and condenser fan motors, high and low pressure cutouts, non-recycling pump down and reset relay, and all necessary timers, and control relays and protective devices.

D. Blower Coil Units:

1. General: Supply, install, and connect (refrigerant piping, power and electrical wiring) wherever shown on the Drawings factory assembled blower coil units consisting of casing, direct expansion evaporator coil, fan, motor, insulated drain pan and throw away filters. Each unit shall be supplied complete with expansion valve, drier, liquid sight glass, electrical wiring and vibration isolators.

2. Casings: Casing shall be not less than 20 gauge steel with baked on enamel finish, lined with not less than 13 mm thick, neoprene coated insulation. Casing shall be provided with removable access panel for full access to all components and shall be provided with mounting holes for suspended mounting.
3. Coils: Cooling coils shall be seamless copper tubes with heavy aluminium fins mechanically bonded to the tubes. Coil shall be complete with male couplers, and operating charge of R-22 and shall be factory pressure and leak tested at not less than 200 psig (1380 Kpa).

4. Fan Motors: Fan shall be of the double inlet centrifugal type with forward-curved blades, belt driven, with an electric 3 speed motor having permanent split capacitor (for single phase motors only), and built-in thermal over load protection. Fan and motor bearings shall be of the permanently lubricated type.

5. Remote Control Station: Supply and install a remote control station wherever shown on Drawings complete with thermostats, on/off switches, controllers and all components indicated on the Drawings together with all the control wiring and its connections to the blower & condensing unit.

2.3 GUARANTEE AND WARRANTED PERIOD

A. All equipment and accessories supplied by the nominated Sub-Contractor under this contract shall be guaranteed for a minimum period of one year and five years for compressors from the date of final completion certificate.

B. All guarantee shall be unconditional. In the event of breakdown, the Contractor shall immediately provide and install a replacement unit of equal or superior performance until such time as the original unit is repaired. Failure by the Contractor to comply within 6 hours of notification, will entitle the Employer to purchase or hire a replacement and seek reimbursement from the Contractor for all related disbursements.

C. The Contractor shall guarantee every piece of equipment from any manufacturing or installation defects for a period of one year, starting from the date of issue of the substantial completion certificate.
# SPECIFICATION SECTION 23 82 19

## FAN COIL UNITS

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NEWTECH CONSULTING GROUP

VITAL KONZEPT ENGINEERING & CONSULTANCY
PART 1 – GENERAL

1.1 SUMMARY
This Section includes fan-coil units with complete valve set as defined and water coils for cooling.

1.2 SUBMITTALS
A. General: Submit each item in this Article according to the Conditions of the Contract Specification Sections.
B. Product Data for capacities, dimensions, electrical connections, sound ratings and tests, for each type of product specified
C. Sample: Provide a sample and demonstrate noise test in near real situation.
D. Wiring diagrams detailing wiring for power and control systems and differentiating clearly between manufacturer-installed and field-installed wiring.
E. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, and other information specified.

1.3 QUALITY ASSURANCE
A. Manufacturer Qualifications: Engage a firm experienced in manufacturing fan-coil units similar to those indicated for this Project and that have a record of successful in-service performance.
B. Comply with ARI 440, or Eurovent, for testing and rating units.
C. Comply with ASHRAE 33 for testing air coils.
D. Electrical components devices and accessories should comply with IEC34.

1.4 COORDINATION
Coordinate layout and installation of fan-coil units and suspension system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

1.5 EXTRA MATERIAL
Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
A. Fan-Coil Unit Filters: Furnish 20% spare filters of total quantity for each filter installed.
B. Fan Belts: Furnish one spare fan belt for each unit installed.

1.6 WARRANTY
A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.
B. Special Warranty: A written warranty, signed by Contractor and manufacturer, agreeing to replace any fan coil unit or component that do not meet requirements or that fail within the specified warranty period.

C. Warranty Period: 5 years from date of Substantial Completion for any component of the fan coil units.
PART 2 – PRODUCTS

2.1 CONFIGURATION
A. Vertical Units: An assembly for floor mounting, including decorative cabinet, filter, chassis, coil, drain pan, fan, and motor in blow-through configuration with hydronic cooling coil.
B. Horizontal Units: An assembly including cabinet, filter, chassis, coil, drain pan, fan, and motor in blow-through configuration with hydronic cooling coil.

2.2 MATERIAL
A. Chassis: Galvanized steel with flanged edges.
B. Coil Section Insulation: Faced, heavy-density, protected face, glass-fiber insulation over entire section.
C. Drain Pans: Galvanized steel, with connection for drain. Drain pan insulated with polystyrene or polyurethane insulation. Connector from pan to drain pipe should be galvanized steel, insulated with the drain trap.
D. Cabinet: Galvanized steel with removable panels.
   1. Vertical Unit Front Panels (eventual and if indicated): Galvanized steel with integral stamped grilles and channel-formed edges, removable for servicing, and with insulation on back of panel.
   2. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge, and attached with safety chain with integral stamped grilles for exposed units.
E. Cabinet Finish: Bonderize, phosphatize, and flow-coat with baked-on primer.
F. Noise requirements: Sound power level of units Lw shall not exceed 45 dB(A) tested according to ISO 3741/88 or ARI 350.

2.3 WATER COILS
Fin-and-Tube Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 2.5 mm. Leak test to 2068 kPa underwater. With manual air vents.

2.4 FAN
Centrifugal fan, with forward-curved, double-width wheels in high temperature resistant plastic (ABS) fan scrolls, directly connected to manufacturer's standard motor. Fan shall be designed for the static and total air pressure requested for the application. Fan shall be housed in noise attenuating enclosure.

2.5 FAN MOTORS
D. Motors for direct-drive units: Multispeed motor with integral thermal-overload protection and resilient mounts.
E. Wiring Terminations: Match conductor materials and sizes of connecting power circuit. Connect motor to chassis wiring with plug connection.
2.6 ACCESSORIES

F. Wall boxes with integral eliminators and insect screen.
G. Vibration isolators.
H. Plastic motor-oiler tubes extending to beneath top discharge grille.
I. Steel recessing flanges for recessing fan-coil units into wall or ceiling.
J. Electrical connection plastic box with a hinged door fitted with an auto-transformer for multiple fan speed selection.
K. Wiring Terminations: Match conductor materials and sizes indicated. Connect motor to chassis wiring with plug connection.
L. Filters: 25 mm thick, throwaway filters in fiberboard frames.

2.7 CONTROL SYSTEMS

M. ON-Off 2/3 way control valves each depending on the location of the FCU in the piping circuit. (near or at the far end of the chilled water circuit).
N. The number of 3 way valves shall correspond to a maximum chilled water flow of 10% of full design flow.
O. Thermostat: Three speed fan switch.
PART 3 – EXECUTION

2.1 EXAMINATION

A. Examine substrates and supports to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance of fan-coil units. Do not proceed with installation until unsatisfactory conditions have been corrected.

2.2 INSTALLATION

A. Install fan-coil units as indicated, to comply with manufacturer's written instructions and NFPA 90A, or as per DTU68.1. and DTU 68.2.

B. Connect fan-coil units and components to wiring systems and to ground as indicated and instructed by manufacturer. Tighten connectors and terminals, including screws and bolts, according to equipment manufacturer's published torque-tightening values for equipment connectors. Where manufacturer's torquing requirements are not indicated, tighten connectors and terminals according to tightening requirements specified in UL 486A.

C. Connect fan-coil units to hydronic piping according to Section "Hydronic Piping." Provide union each connection.

D. Testing: After installing fan-coil units and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

E. The noise level inside the occupied area should be supervised and controlled before commissioning, a technical report should prove by the calculation and with the confirmation of the manufacturer that noise is within the requested limit: NC 30 for bedroom, NC 35 for offices, reception and working areas.

F. Remove and replace malfunctioning units with new units, and retest.

2.3 FIELD QUALITY CONTROL

A. Startup Services: Engage a factory-authorized service representative to provide startup service.

B. Site engineer to prepare a complete schedule for his reception with complete information about the test he performed for the response of each FCU to the requested test: water in and out, complete air test on flow and temperature, thermostat response to cooling etc....

C. Drainage testing to be performed with water jet on the drain pan, field engineer to certify the test and the correctness of the drain pan inclination and the correct flow of drained water.

D. Clean the strainer at each step of the flushing and disinfections procedure

E. Operate fan motor to verify proper rotation.

F. Operate through each stage to verify proper operation and electrical connections.

G. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

End of Section 23 82 19
### Division 26 00 00
Electrical

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## PART 1  GENERAL

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PART 1 – GENERAL

1.1 GENERAL INSTRUCTIONS

Works under this section shall be governed by Conditions of Contract.

1.2 SCOPE

A. After completion of the Electrical Work, the complete systems shall be tested thoroughly before commissioning. Any modifications or repairs necessary on completion of the tests shall be done at the Sub-Contractor's expense.

B. The tests outlined herein shall be in addition to, and not substitution for, the tests of the individual items at the manufacturer's plant. Insulation and grounding resistance test shall be made before operating tests. Proper rotation shall be determined before permanent connections are made.

C. All testing equipment on Site shall be provided by the electrical Sub-Contractor.

D. The Sub-Contractor shall make the necessary openings in the circuits, for the testing instruments and shall place and connect all instruments, equipment, and devices necessary for the tests. Upon completion of the tests, these shall be removed and all circuits connected to their permanent condition.

E. The tests shall be conducted in the presence of the Engineer and local power authority’s representative. The Engineer shall be notified seven calendar days or more in advance when any test is to take place, and it shall not be started without his permission.

F. Certificates when so required shall be submitted for any equipment installed under this contract originating from an authorized inspecting body in the country of the manufacturer.

G. Unless otherwise specified, the Sub-Contractor shall supply the electric current necessary for the tests.

H. The Sub-Contractor shall state and guarantee the particulars as specified in his tender documents. Such guarantees shall not be departed from, without written permission by the Engineer. If such guarantees are not respected, the Engineer has the right to reject the faulty equipment.

I. The Sub-Contractor shall submit four copies of all tests results.

J. Test shall include the following:

1. Insulation megger tests on wires & cables.

2. Continuity and resistance tests.

3. Socket outlets proper wiring tests.

4. Operational tests on all electrical equipment.

5. Insulation resistance tests of motors, distribution boards and panels.


7. Earth loop impedance test for socket outlets.

8. Earth resistance measurements test for HV/LV.
1.3 DESCRIPTION OF TESTS AND METHODS

A. Insulation Megger Tests

Tests for insulation level shall be a 500-volt Megger. A minimum of one meg q ohm (1,000,000 ohms) applying to the complete installation shall be obtained. This means that when all the phase wires at the panel board are connected together and to the testing instrument, all switches closed, all appliances inserted in the circuit, all neutral wires left in the air, and the other end of the Megger is connected to the grounding, then there shall be a minimum of 1 mega ohm between the whole of the installation taken together and the grounding.

B. Continuity & Resistance Tests

1. A continuity test to ensure that all connections have been made properly shall be made. This can be done by the use of a bell set. Test shall also include ensuring all switches and other interrupting devices breaking the phase wire and not the neutral wire.

2. Test shall include, in addition to checking continuity of current carrying wires and cables, continuity of grounding conductors. This shall be done through a Megger which shall produce an alternating current of a magnitude equal to one and a half times the rating of the circuit under test with a maximum of 25 amps.

C. Socket outlets Proper Wiring Test

All socket outlets shall be connected properly such that looking at the face of the socket outlet the live connection shall be on the right, the neutral on the left and the earthing at the top.

D. Operational Tests

1. The Contractor shall demonstrate the proper operation of circuit breakers, switches and any other equipment as requested by the Engineer, or as specified elsewhere in these Specifications.

2. Each motor and associated equipment shall be run as nearly as possible under normal operating conditions for as long a time as is necessary to demonstrate correct alignment, wiring capacity, speed, and satisfactory operation. The motor shall be loaded to full capacity, or as near there to as possible.

E. Insulation Resistance Tests of Motors

All motors shall be tested for insulation in accordance with the requirement of IEC Standard. Two copies of the test data shall be submitted.

F. Testing of Lighting Installation

The Contractor shall demonstrate the proper operation of all lighting fixtures.

End of Section 26 01 26
SPECIFICATION SECTION 26 05 00
BASIC ELECTRICAL MATERIALS AND METHODS

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1.2 Scope
1.3 Codes and Standards
1.4 Abbreviations
1.5 Interference and Erroneous Locations
1.6 Climatic Conditions
1.7 Local Electrical Authorities' Requirements
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3.6 Operation, Maintenance and Spare Parts Manual
3.7 Building Management System Requirements
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PART 1 – GENERAL

1.1 GENERAL INSTRUCTIONS
Works under this section shall be governed by conditions of contract.

1.2 SCOPE
These specifications cover the following systems that are intended to be used for the project in accordance with the drawings and as directed and approved by the engineer:

A. 26 05 26: Earthing System
B. 26 09 44: Lighting System
C. 26 32 00: Power System
D. 26 33 23: Emergency Lighting System
E. 27 30 00: Telephone & Low Current Systems
F. 28 31 00: Fire Alarm System
G. Other Misc. Systems

1.3 CODES AND STANDARDS
A. The contractor shall carry out all electrical works in accordance with the latest issue of the "regulations for the electrical installations published by the institution of electrical engineers (iee) referred to as iee wiring regulations hereinafter, and where not in contradiction with the latest requirements of local electrical authorities, civil defence administration.
B. If any redesign or modification of the works is necessitated by the adoption of another approved code or due to local electrical authorities or safety instruction requirements, the extra cost incurred (if any) both for redesign and material shall be borne by the contractor.
C. All equipment and materials supplied for this contract shall be manufactured in strict compliance with the latest relevant recommendations of the iec, if available. otherwise they shall comply with the latest relevant euro norm specifications unless otherwise specified or approved.

1.4 ABBREVIATIONS
A. The Following Abbreviations Shall Have The Significance Set Forth Opposite Each:- Nec: National Electrical Code (STANDARD 70) (USA).
C. BS: British Standards.
D. IEE: Institution Of Electrical Engineers (UK).
E. EN: Euro Norm (European Harmonized Standards).
F. UL: Underwriters Laboratories.
G. VDE: Verband De Utscher Elektro Techniker.
I. IEEE: The Institute Of Electrical & Electronic Engineers (USA).
J. NEMA: National Electrical Manufacturers' Association (USA).
L. DIN: German Industrial Standards.

1.5 INTERFERENCE AND ERRONEOUS LOCATIONS
A. The contractor shall verify on site all data and final locations of work done under other sections of these specifications, required for arranging the electrical works.
B. In case of interference with other works or erroneous locations with respect to equipment or structures, the contractor shall supply all labour and materials necessary to complete the work in an acceptable manner.

1.6 CLIMATIC CONDITIONS
A. Materials and equipment shall be suitable in all respects for operation on electrical systems under following climatic conditions:-
B. Temperature - 50 degree c. max.
C. Relative Humidity - 100 Percent max.

1.7 LOCAL ELECTRICAL AUTHORITIES' REQUIREMENTS
A. The contractor shall attend to and afford all facilities to the local electrical authorities and shall provide oil drainage pits, terminal cable pits, terminal boxes for cables, underground ducts, etc. to facilitate all main feeder work. the contractor shall be responsible for foreseeing any requirement as requested by the above mentioned authorities, and shall follow the engineer's instructions on site.
B. The contractor shall be responsible for preparing workshop drawings concerning transformer rooms, (if any) electrical (meter) rooms, feed-in routings, and shall consult the electrical authorities in accordance with the engineer's instructions, to seek the approval of these authorities. the contractor shall also be responsible for follow up of the application for electrical connection. the application form shall be filled in by the contractor who shall follow up with the concerned authorities for final electrical connection to the project.

1.8 ELECTRICAL SERVICE
A. The electrical power system will operate on 240 volt/415+10% volt, 3-phase, 4-wire, 50 hz system.
B. The low current systems shall operate on the voltages specified or as recommended by the respective system manufacturer to the acceptance of the engineer.
1.9 TERMINOLOGY

A. The attention of the contractor is directed to section 01 10 00 of the specifications for meanings of certain contractual terms.
B. Terminology is used in the sense outlined in the regulations and conditions of contract.

1.10 SHOP DRAWINGS, SAMPLES AND OTHER SUBMITTALS

A. The contractor shall submit shop drawings and samples as called for in section 01 33 00 of the specifications and the conditions of contract under the relevant heads. No equipment or system, for which shop drawings and/or samples are required, shall be ordered or installed unless all such drawings and/or samples are duly reviewed and approved by the engineer.

B. The contractor shall, upon the request of the engineer provide plain paper copies of the standards' extracts to which references are made in the specifications.

C. Two copies of the brochures submitted shall be originals as published by the manufacturer. Other copies may be clear plain paper copies.

D. Submitted brochures shall include at least two copies of manufacturer's original publications, other copies may be clear plain paper copies.

1.11 "AS-BUILT" DRAWINGS

"As built" drawings shall be submitted as called for in section 01 33 00 of the specifications, under "as-built drawings".
PART 2 – PRODUCTS

2.1 MATERIAL

A. All electrical materials and equipment to be used for the project shall be new and shall be manufactured by one of the manufacturer listed in acceptable manufacturers’ list in relevant section. Materials proposed to be used shall fulfill the following conditions:-

1. Local availability of spare parts.
2. Local technical support with factory trained technicians.

2.2 EQUIPMENT SUPPLIED AND INSTALLED BY OTHERS

Certain items of control and other equipment pertaining to plumbing, air conditioning, etc indicated "by others" on the electrical drawings are shown for connection only. Such items are not supplied as a part of the electrical work, but all connections including power and control to such equipment shall be done under this section.

2.3 EQUIPMENT NOT IN CONTRACT (NIC)

Equipment so indicated or noted will not be in contract. Connections to such equipment will not be carried out by the contractor unless otherwise indicated or noted.

2.4 NAMEPLATES

A. Nameplates in arabic and english shall be installed on all devices or pieces of equipment for which the use or identification may not be readily apparent, such as, but not limited to, starters, relays, contactors, controls, pushbuttons, indicating lights, switches.

B. Nameplates shall be made of laminated sheet plastic, 2.5 mm thick, or of anodised aluminium, approximately 1.5 mm thick, engraved to provide black letters on a white background, and fastened in place with corrosion-resistant screws, or as specified by local authorities. Nameplates for ip55 panels shall be fixed with adhesives.

C. Nameplates shall also be provided on all manufactured assemblies to identify the assembly as well as feeders, circuits, compartments, switches, internal components, etc.

D. Nameplates shall be located in a position to be easily readable after completion of the installation of the equipment.

E. Nameplates for equipment weighing more than 15 kgs, shall be marked giving the approximate weight to the nearest + or -5%.
3.1 GENERAL REQUIREMENTS

A. The Contractor shall supply all necessary labour and material, and shall install, complete and make ready for use, the above mentioned systems including the installation and wiring of miscellaneous equipment and devices, as indicated on the drawings and as herein specified.

B. The Contractor shall carry out the whole of the Electrical works in a workman like and substantial manner and in strict conformance with the codes, Standards and requirements listed in the following clauses, or approved equal.

C. All equipment and material supplied for this project shall be manufactured in strict compliance with the standards listed in the following clauses or acceptable equal.

D. The Contractor's attention is directed to the requirements of the general conditions of contract and division 01 of the specifications as applicable to the Electrical Work.

E. If actual ratings of equipment supplied under other sections are different than the values indicated on the Drawings, the Contractor shall implement all necessary modifications at no extra cost, to the acceptable of the Engineer and as approved relevant Local Authorities.

3.2 ENGINEER'S DRAWINGS

A. The Engineer's Drawings issued with these Specifications are complementary to these Specifications.

B. These Drawings indicate the approximate location of all-electrical devices and equipment. The exact and final location shall be subject to the prior acceptance of the Engineer on Site.

C. The Contractor shall check Architectural, Structural, Air-Conditioning, Plumbing and any other available Drawings to avert any possible installation conflicts. Should drastic changes from original plans be necessary to resolve such conflicts, the Contractor shall secure the Engineer's written permission on necessary adjustments before any installation work is started.

D. All accessories and appurtenances that the Engineer deems functionally necessary for a complete installation shall be supplied and installed by the Contractor whether or not explicitly indicated or described at no extra charge.

E. Discrepancies shown on different Drawings or between Drawings and actual Site conditions, or between Drawings and Specifications shall be brought to the attention of the Engineer for a decision.

3.3 MODIFICATIONS

A. If during the work, the Contractor wishes to make changes or modifications, then these modifications shall be submitted to the Engineer for approval. If these changes result in extra expenses in design and/or material these expenses shall be borne by the Contractor.

3.4 PROTECTION OF ELECTRICAL EQUIPMENT

A. Electrical equipment shall be protected against mechanical damage and from the weather especially from water dripping or splashing upon it, at all times during shipment, storage, and construction.
B. Equipment shall not be stored outdoors. Where equipment is installed or stored in moist areas, such as unheated buildings, open spaces, etc., it shall be provided with an acceptable means to prevent the moisture damage. This may be a uniformly distributed source of heat to prevent condensation.

C. Should any equipment or material be subjected to possible damage by water, it shall be dried out thoroughly and put through a special dielectric test as directed by engineer, at the expense of the Contractor or shall be replaced by the Contractor without any additional charge.

D. Should any equipment or material be subjected to possible mechanical damage, the Contractor shall repair or replace the damaged equipment as instructed by the Engineer.

3.5 ACCEPTANCE TESTS

Any work which is not in accordance with the Specifications or to the satisfaction of the Engineer and/or local power authorities shall be removed and repaired at the Contractor's expense. All material must be factory finished and/or painted to the approval of the Engineer.

3.6 OPERATION, MAINTENANCE AND SPARE PARTS MANUALS.

The Contractor shall provide the Employer with 3 complete sets of operation & maintenance manuals covering step by step operation and maintenance aspects of all electrical equipment, as applicable. These manuals shall also include information for ordering spare parts for such equipment.

3.7 BUILDING MANAGEMENT SYSTEM REQUIREMENTS

The Contractor shall be responsible for co-ordination between suppliers of all equipment linked to Building Management System (BMS) in order to integrate and provide all necessary interface units inside the equipment connected to Building Management System network.

3.8 AUDIO VISUAL SYSTEM REQUIREMENTS

The Contractor shall be responsible for co-ordination between the suppliers of all audio visual system equipment, in order to provide necessary containment, interfaces, power supplies, etc., required for installation of this equipment.

3.9 WARRANTY

A. The Contractor shall provide appropriate warranties, where applicable, indemnifying the client against the failure of supplied goods/equipment within the prescribed period.

B. The warranty details shall be displayed on all goods/equipment. These details shall include:
   1. Warranty start and end date.
   2. Suppliers contact phone number.
   3. Local service centre

C. The warranty details shall be engraved on appropriate brass plates and shall be affixed to the relevant goods/equipment.
African Development Bank - Sudan
Relocation and Outfitting Project
Volume III – MEP Specifications

SPECIFICATION SECTION 26 05 19
WIRES & CABLES

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1.1 GENERAL INSTRUCTIONS

Works under this section shall be governed by conditions of Contract.

1.2 SCOPE

A. The Contractor shall supply, install and connect all wires and cables necessary for complete electrical system, as indicated on the drawings, as required and as specified herein.

B. Current ratings for calculating the size of the underground cables shall be those contained in the relevant tables of ERA report No. 69-30, part I, II, III or IV, as may be appropriate to the type of cable being used. The ratings shall be and adjusted where necessary to comply with the recommendations of ERA report No. F/T186.

1.3 APPLICABLE STANDARDS

A. Single Core Cables : BS 6004

B. XLPE Armored Cables, 600V/1000V : BS 5467

C. Insulated Flexible Cords : BS 6500

1.4 APPROVED MANUFACTURERS

A. Wires and cables shall be manufactured by one of the following manufacturers or approved equal as listed in the “Electrical Manufacturer List”.

B. Lighting & power

1. DUCAB (UAE)

2. BICC (UK)

3. PIRELLI (UK)

C. Fire Alarm

1. Pirelli, UK (FP200-Gold)

2. BICC, UK (Flamsil)

3. Fire-TUF, (UK)

D. Cable glands

1. BICC, UK (Flamsil)

2. CMP, (UK)

3. HAWK(UK)

E. GI. Boxes

1. MK (UK)

2. CRABTREE (UK)

3. BARTON (UK)
 PART 2 – PRODUCTS

2.1 SINGLE CORE AND MULTI-CORE ARMORED CABLES

A. Cables shall be single or multicore as described in the schedules or indicated on the drawings.

B. Cables shall be armored and PVC sheathed. Multi core cables shall be steel tape or single wire armoured and single core cables shall be aluminum strip armored.

C. The core insulation of armored cables shall be colored as follows:

<table>
<thead>
<tr>
<th>Cable</th>
<th>Color</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single core</td>
<td>Black</td>
</tr>
<tr>
<td>2 core</td>
<td>One black and one red</td>
</tr>
<tr>
<td>3 core</td>
<td>Red, yellow, blue</td>
</tr>
<tr>
<td>3½ core or 4 core</td>
<td>Red, yellow, blue, black</td>
</tr>
</tbody>
</table>

D. Conductors shall be either plain or annealed tinned copper complying with BS 6360. Aluminum conductors where specified shall comply with BS 6791.

E. The insulation of the cable shall be PVC, polythene, XLPE, EPR or LSF materials as described in the schedules or indicated on the drawings.

F. Armor shall consist of a single layer galvanised steel wire complying with BS 1442 or aluminum strip complying with BS 2897.

G. Where cables run indoors for more than 10 m, the sheaths shall be of LSF grade (Low smoke and fumes) as specified in BS 6425, and the cable shall be certified by BASEC (British Approvals Service of Electric Cables). The level of acid gas emission shall not exceed 5 percent. The LSF sheath shall possess suitable mechanical durability and water resistance properties for the application and the environment in which they are used.

2.2 WIRES & CABLES - LIGHTING & POWER

A. Conductors shall be of high conductivity annealed copper with concentric stranding for stranded conductors, to BS 6360 or approved equal.

B. Minimum conductor size used including earth wire shall not be less than 2.5 mm².

C. All wires for lighting and power systems pulled inside conduits shall be single core, insulated with PVC compound, of grade not less than 450/750 volts, to BS 6004.

D. Armored cables shall be multi core unless otherwise indicated, PVC sheathed, galvanised steel wire or double tape armored and overall PVC extruded sheathed, of grade not less than 600/1000 volts to BS 6346.

E. Single core armored cable where used shall have a hard drawn aluminum wired armoring.

F. Conductors shall be solid-stranded.

G. Flexible cords for connection of fixtures to circuit-wiring shall have finely stranded copper Conductor with PVC insulation, type NYFAF, 415 V grade.
2.3 FLEXIBLE CORDS
A. Cords used for water heater connections shall be of high conductivity tinned copper wires,
(2.5 mm\(^2\) unless otherwise indicated) insulated with ethylene propylene rubber, three cores
 twisted together, filled and sheathed with chlorosulphonated polyethylene (EPR CSP),
300/500 V rated, and shall withstand an operating temperature of 85\(^\circ\)C, to BS 6500.
B. Cords used for pendant lighting points and between lighting outlet above false ceiling to
lighting fixture shall be circular two core (1.5 mm\(^2\)) silicon rubber insulated, glass fiber
braided 300/300 V rated, shall withstand an operating temperature of 105\(^\circ\)C, to BS 6500.
C. Cords used for extract fans shall be of plain annealed copper conductor (1.5 mm\(^2\)), PVC
insulated, circular twin cores twisted together, PVC overall sheeted 300/500 V rated, shall
withstand an operating temperature of 70 \(\circ\)C, to BS 6500.

2.4 WIRES AND CABLES - TELEPHONE
Wires and cables shall be supplied and installed to the approval of Local Telephone
Company, unless otherwise specified in the drawings. The Contractor shall attend and afford
all facilities to the Telephone Company and shall take prior written approval of the adequacy
for the proposed conduits for the telephone system before installation of the conduit system.

2.5 CABLES - CENTRAL ANTENNA SYSTEM
A. If required, cables shall be coaxial type with inner conductor of solid accurately dimensioned
electrolytic copper, insulation of high grade solid polyethylene, outer conductor of a
longitudinally overlapping copper foil tightly enclosed in a copper-wire braiding, outer sheath
of a pliable PVC.
B. Characteristic impedance shall be 75 ohms.
C. Inner conductor shall have a minimum of 0.7 mm diameter.
D. Overall diameter of cable shall not be less than 7 mm.
E. Cable shall have a tensile strength on outer conductor of 20 kgf for one minute.

2.6 CABLES - INTERPHONE & BELLS
Wires shall be rated for a minimum 250 volts service. The conductor shall be tinned
annealed I strand, high conductivity copper, insulated with 0.5 mm thick PVC compound.
Conductor shall have a minimum of 0.7 mm\(^2\) cross-section.

2.7 FIRE ALARM CABLES/WIRING
A. Cables of the Fire alarm system shall be of high grade fire cell and fire resistant cables
complying with the local authorities, regulations, BS Standards. BS 6387:1994 category
(BZW) & BS 6425: Part 1: 1990, and all cable sheathes shall be LSF grade (Low smoke and
fumes) complying with BS 6425: Part 1: 1990 & certified by BASEC & LPCB.
B. All detectors/loops shall be wired in 1.5 mm\(^2\) fire proof cables and cables for sounders
circuits shall be with 2.5 mm\(^2\) fire proof cables as specified above in item (1) and wired
directly from the Control Panels or through local interface units, with monitoring battery
backup power supply.
C. At all the termination points, cable shall be provided with an approved cable connection to
outlet boxes, panels, devices or fire alarm equipment, fittings, etc., the same shall be of fire
rated threaded gland type with locknut and shall be made according to manufacturer's
instructions.
D. G.I. conduits shall be used wherever the cable is used exposed to vision or above false ceiling void and non-metallic rigid PVC conduits may be used where embedded in walls or slabs to the approval of local fire authorities and acceptance of Engineer.

2.8 CABLES - SOUND SYSTEM
A. Wires for loudspeakers shall be rated for a minimum 250 volts service. The conductor shall be tinned annealed 1 strand, high conductivity copper, insulated with 0.5 mm thick PVC compound. Conductor shall have a minimum of 0.7 mm square cross-section.
B. Cables for microphone shall be 2 x 0.5 mm square, screened.
C. Where sound system is used as a voice alarm, cabling of the system shall have fire retardant sheathing and of the same fire resistance degree of the fire alarm cables.

2.9 CONTROL CABLES
A. Control cables where used underground direct burial shall comprise stranded annealed copper conductor of minimum 1.5 mm$^2$ cross-section insulated with high dielectric polyvinyl chloride, nylon sheathed with a tape binder applied over the assembly, overall PVC jacketed.
B. Number of conductors shall be equal to the maximum number of functions plus 20% spare.
C. Cable shall be 300/500V insulation grade.
D. Junction boxes shall include all necessary terminal connector boards of DIN rail Viking Terminal type with proper labels.
E. Contractor shall make sure that the cross-sectional areas of the conductors are sufficient to cater for the voltage drop due to the long runs involved.
F. Control cables where used in ducts underground or in conduits above ground shall comprise stranded annealed copper conductor of minimum 1.5 mm$^2$ cross-section for cables in ducts and 0.75mm$^2$ for cables in conduits insulated with high dielectric polyvinyl chloride, and PVC sheathed.

2.10 CONNECTORS AND TERMINAL BLOCKS
A. For the wiring of circuits consisting of wire sizes 6 mm$^2$ and smaller such as for lighting branch circuits, self-insulated pressure type connectors shall be utilised for all splices or joints.
B. For the wiring of circuits consisting of wire sizes 10 mm$^2$ and larger shall be of the bolted pressure type, DIN rail Viking model and with a pre-insulated sleeve.
C. Connectors shall be manufactured from high conductivity copper, electro tin-plated.
D. Connector bodies shall be manufactured from Polyamide.

2.11 CABLE LADDERS
A. Cable ladders shall be manufactured from 14 SWG Mild steel, with hot-dip galvanised finish.
B. All parts like flat elbows, offset reducers, straight reducers, cross pieces, tee pieces, drop outs, etc... as well as accessories shall be furnished as to function, and to the manufacturers standards.
2.12 CABLE GLANDS
A. Cable glands shall be provided at the termination of armored cables at the enclosure of a distribution board or any other equipment.
B. Whether installed indoors or outdoors, all cable glands shall provide protection to IP 55 as a minimum.
C. Glands for armored cables shall be made of brass and incorporate an armor clamp and compression type neoprene rubber seal over the inner sheath. For cable glands which may be exposed to rain or spraying water (e.g. due to hosing down) an additional neoprene compression seal over the outer sheath shall be also provided.
PART 3 – EXECUTION

3.1 INSTALLATION OF WIRES & CABLES

A. All wires shall be installed in accordance with the applicable provisions of the listed codes and as indicated on the Drawings.

B. The number of wires and sizes of conduits indicated on the Drawings are a guide only and are not necessarily the correct number and sizes necessary for the actual equipment installed. The Contractor shall install as many wires and conduits as required and necessary for a complete electrical system and shall provide adequately for the equipment actually to be installed.

C. Where more than one conductor is used per phase, each phase, neutral if any and ground wires shall be run in each metallic or non-metallic conduit.

D. Conductors shall be continuous from outlet to outlet and no splices shall be made except within outlet or junction boxes.

E. At every outlet and pull box, wires and cables passing through, shall be left slack by an amount equivalent to 15 cm of cable length to allow inspection and connection to be made therein.

F. No cable bend shall have a radius of less than eight times its diameter.

G. The Contractor shall not change any circuit number, especially from a phase to a different phase. If such a change is necessary due to modification on site, the Contractor shall bring this matter to the attention of the engineer.

H. All conductors to be contained within a single conduit shall be drawn in at the same time.

I. A wire pulling compound shall be applied to conductors being drawn through conduit. Pulling compound shall be soap tone or other approved material.

J. Only cables forming part of a lift installation if any may be run in a lift shaft.

K. Wires and cables for feeders, sub-feeders, control, and branch circuit wiring shall be color coded as follows:

<table>
<thead>
<tr>
<th>Color</th>
<th>Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red</td>
<td>A or 1</td>
</tr>
<tr>
<td>Yellow</td>
<td>B or 2</td>
</tr>
<tr>
<td>Blue</td>
<td>C or 3</td>
</tr>
<tr>
<td>Black</td>
<td>Neutral</td>
</tr>
<tr>
<td>Green</td>
<td>Equipment grounding</td>
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L. Wire and cable sizes shall be as indicated on the Drawings; however in no case shall their size be smaller than required by the listed Code.

M. Unless otherwise indicated, no conductor for lighting and power wires shall be smaller than 2.5 mm².
N. All branch circuits for lighting and appliances shall be single conductor cables run inside conduits, unless otherwise indicated.

O. Feeders and sub-feeders shall be either single conductor wires pulled inside conduits or multi-conductor cables run exposed on walls or in trenches as shown on the Drawings.

P. Single cables shall be fixed directly to walls or ceilings. Where 2 or more cables are run in parallel, they shall be fixed on galvanised steel perforated trays or on other approved special cable supporting and protecting arrangement.

Q. Cables shall be fixed to supporting structures with approved galvanised cast steel clamps at distances not exceeding 20 diameters.

R. Armored cables used in vertical shafts shall be the steel wire armored and not the tape type.

S. No joints or splices shall be accepted on main feeders, unless with an approved means, which shall be to the approval of local power supply authority.

T. Cable shall be supported at not more than 75 times the cable outer diameter intervals by means of approved staples, strap, hangers or other fittings to build structure or to specially designed brackets.

3.2 IDENTIFICATION OF WIRES & CABLES

A. Individual conductor or circuit identification shall be carried throughout, with circuit numbers or other identification clearly stamped on terminal boards and printed on directory cards in distribution cabinets and panel boards.

B. In junction boxes, cabinets, and terminal boxes where the total number of control, indicating, and metering wires is three or fewer and no terminal board is provided, each wire including all power wires, shall be properly identified by means of a plastic-coated, self-adhesive, wire marker.

C. Wires including motor leads and other power wires too large for connection to the terminal boards shall be identified by wire markers as specified above.

D. In manholes, hand holes, pull boxes, junction boxes and at both terminals each wire and cable shall be properly identified by a laminated plastic tag located so as to be easily seen. Wires and cables shall be identified by cable number indicated on the Drawings by using identification ferrules for wires and laminated plastic/metallic tags on cables.

3.3 CABLE TERMINATIONS

A. All cables terminations or joints other than sub-circuit wiring shall be carried out by using compression type connectors or lugs of size and type suitable for required application.

B. Correct type hydraulic crimping tools shall be used for each particular application. Manufacture’s recommendations shall be strictly followed particularly in maintaining the recommended crimping tool pressure.

End of Section 26 05 19
## SPECIFICATION SECTION 26 05 26

**EARTHING SYSTEM**

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1.1 GENERAL INSTRUCTIONS
Works under this section shall be governed by Conditions of Contract.

1.2 SCOPE
Provide earthing system(s) for all Buildings as indicated on Electrical drawings, schedules and specified herein.

1.3 CODES AND STANDARDS
A. The Earthing system shall be in full compliance with the requirements of the IEE Wiring Regulations, Local Authorities Practices and the Specifications.
B. Any modification required by Local authorities shall be done at no extra cost.
C. The impedance of equipment (earth loop) shall comply with the requirements of IEE wiring regulation.
D. The earthing resistance shall be in accordance with BS 7430 and in compliance with requirements of Local Power Authority’s (MEDC).
E. All earthing and bonding installation and equipment, shall comply with the requirements of the BS 7671 and BS 7430.
F. All Equipment earthing of the Electrical Works through a removable link at the Main Distribution Switchboard connecting the main earthing bus to the neutral bus. If no main switchboard is included in the works, a peripheral earth bus shall be provided in the Meters Room to which all the equipment earthing shall be bonded. The earthing bus shall in turn be bonded to the Local Authorities Low Tension Pillar neutral.

1.4 APPROVED MANUFACTURES
The proposed earthing system materials and accessories shall be manufactured by one of the following manufacturers or approved equal, as listed in the “Electrical Manufacturers List”.

PART 2 - PRODUCT

2.1 MATERIALS

A. Unless otherwise specified all materials used for earthing shall be of copper or approved copper alloys, and shall be specially manufactured for the purpose.

B. The complete earthing system shall be electrically and mechanically continuous to provide an independent fault current return path to the earthing source.

C. Bolted connections shall be of the multiple bolt type. Bolts, washers and stop nuts shall be of high copper alloy. Ferrous hardware will not be accepted.

D. The impedance of equipment (earth loop) at any point in the electrical wiring system shall be sufficiently low to limit the voltage to earth and to facilitate the operation of the circuit protective devices in the circuits. Otherwise earth leakage circuit breakers shall be used.

E. Locations where the electrode is above water table, in rock or where there is soil is chloride free. 5/8" or ¾" diameter copper-bonded steel rod, the copper shall be 99.9% pure electrolytic molecularly bonded onto a low carbon steel core to BS 970 with a high tensile strength of at least 600 N/mm², the copper thickness shall at least 0.25 mm. the rod shall be complete with driving stud, high strength copper alloy connectors and screw in spike.

F. Earthing systems for sub-stations shall be in accordance with BS 7430 and the Local Electricity Authority regulations.

G. The earth system shall be tested in accordance with BS 7430.

2.2 PROTECTIVE CONDUCTORS

A. Earthing wires (protective conductors) are not shown on the Drawings. All circuits running in conduits or in flexible conduits shall have earthing insulated conductors of minimum sizes as follows:

<table>
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<td>S less than or equal to 16</td>
<td>S</td>
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<tr>
<td>S greater than or equal to 16</td>
<td></td>
</tr>
<tr>
<td>But less than or equal to 35</td>
<td>16</td>
</tr>
<tr>
<td>S greater than 35</td>
<td>0.5 S</td>
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B. If more than one circuit is included in a conduit, one protective conductor per neutral or per three phases circuit with no neutral shall be provided.

2.3 EARTHING PIT

A. The earthing rod shall be constructed from copper clad steel rod. Copper sheath shall be 99.9% pure electrolytic copper. The steel core shall be of carbon steel, with tensile strength min 97,000 psi yield strength at 0.2% offset 85,000 psi, proportional limit 57,000 psi, percent of elongation 13%. Rod shall be cold drawn.

B. Earth pits shall be installed at least 2 meters away from building façade.

2.4 PROTECTIVE CONDUCTORS

A. Protective conductors shall be supplied and installed to in accordance with BS 7671.
PART 3 - EXECUTION

3.1 EARTHING INSTALLATION
   A. Two separate earthing installations shall be provided. One installation shall be the System
      earthing and the other shall be the Authorities Service Equipment Earthing.
   B. Where earthing terminals are brazed to equipment, the metal shall be thoroughly cleaned
      prior to brazing and the impaired surface repainted to prevent corrosion.

3.2 SYSTEM EARTHING
   A. The System Earthing shall consist of earthing pits connected in parallel if practicable, or
      shall consist of 95 mm² ring (counterpoise) buried under ground at a depth of 1 meter
      minimum around the periphery of the building or substation if the latter is a separate
      structure. The specified system shall be in accordance with the project layout and location
      as indicated on the drawings.
   B. The main earthing bus of the main switchboard(s) if any shall be connected to the system
      earthing by a 95 mm² bare copper cable via a 40 x 5 mm main earthing bus bar fixed on the
      wall in an approved location.

3.3 SERVICE EQUIPMENT EARTHING
   A. The service equipment earthing shall be a separate earthing installation consisting of
      earthing pits connected in parallel. These pits shall be at least 8 meters away from the
      system earthing if practicable otherwise the service equipment earthing shall be bonded to
      the system earthing and the combined resistance shall be less than 1 Ohm.
   B. To this installation will be connected: the ring main unit earthing bar, the transformer(s) and
      HT switchgears, HT cable sheaths, all exposed structural metal works including metal cable
      trays when the substation is situated above a basement.
   C. Connection material and sizes shall be as approved by the Local Authorities.

3.4 EQUIPMENT EARTHING OF THE ELECTRICAL WORKS
   A. Equipment earthing of the Electrical Works shall consist of bonding all non-current carrying
      metal parts of the Electrical installation to the System earth (TN-S system as per IEE Wiring
   B. Non-current carrying metal parts of the electrical installation shall include such items as
      cabinets, exposed metal parts of apparatus as well as enclosures, doors, grill, etc.,
      protecting or shielding electrical equipment from direct access to unauthorized personnel.
   C. The series earthing of one piece of equipment to another will not be permitted. All equipment
      earthing connections shall be tapped from the applicable earth source.
   D. The cable armoring will not be accepted as equipment earthing conductor.
   E. All socket outlets, power apparatus, lighting fixtures and switches shall be earthed.
   F. No point on the neutral shall be connected to the earth system except as described under
      "System Earthing".
   G. Additional earthing pits may be shown on the drawings at different locations. These pits shall
      be bonded to the earthing bus of the relevant switchboards or panel boards as applicable in
order to reduce the earthing resistance. Neutral at such points shall not be bonded to the earthing system.

H. Shells of all water heaters shall be connected to the neutral and earthing of the corresponding circuit.

I. Bonding connections to gas and water pipes as required by the BS 7671 shall be made as near as practicable to the point of entry. These connections shall be made with solid copper conductors of minimum cross section in accordance with BS 7671. These bonds shall be installed as inconspicuously and nearly as possible. The connections shall be visible after installation.

J. Bonding conductors shall comply with BS 7671.

K. Tests of individual and combined LV system earthing electrodes shall be carried out and the results recorded for presentation in accordance with BS 7671.

3.5 STRUCTURAL STEELWORK BONDING

A. Steelwork bonding shall be installed utilizing bolted or (thermal process) welded connections. Close coordination shall be made with other trades to ensure the timely installation of bonding conductors during the construction program. Bonding of structural steelwork shall be carried out in accordance with the BS 7671 and shall include but not be limited to the following examples:

B. Exposed Main Structural Columns & Beams.
C. Metallic Louvers and Grilles.
D. Crane Runway Beams
E. Steel Door and Frames
F. Reinforcing Steelwork Bars and Mesh
G. Mechanical and HVAC Plant

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1.1 GENERAL INSTRUCTIONS

Works under this section shall be governed by conditions of contract.

1.2 SCOPE

A. The Contractor shall supply and install a complete conduit system as shown on the Drawings and as herein specified. The system shall include conduits, fittings (couplings, bends, boxes, cover plates, reducers, adaptors, etc.) and all necessary parts to install a complete conduit system.

B. Conduits and fittings shall be distinctively marked as manufactured for electrical purposes.

C. Conduit runs are shown diagrammatically to outline the general routing of the system. The installation shall be made to avoid interfering with pipes, ducts, structural members or other equipment. Should structural or other interferences prevent the installation of the conduits, or setting of boxes, cabinets, or other electrical equipment, as indicated on the Drawings, deviations must be approved by the Engineer, and after approval, shall be made without additional charges. The number of conduits shall not be less than that indicated on the Drawings.

1.3 APPLICABLE STANDARDS


1.4 APPROVED MANUFACTURERS

Conduits accessories shall be manufactured by one of the following manufacturers or approved equal as listed in the Electrical Manufacturer’s List:-

A. PVC conduits & fittings (rigid & flexible)
   1. MK – EGA (UK)
   2. Deco duct – UAE (Very Heavy Gauge)
   3. Marshal tuflex (UK)

B. Metallic conduits & fittings
   1. Simplex (UK)
   2. Burn Tubes (UK)
   3. Barton (UK)

C. Flexible metallic conduits
   1. KOPEX (UK)
   2. Adaptaflex (UK)
   3. Flexicon (UK)
PART 2 - PRODUCT

2.1 CONDUITS

A. Conduits and conduit fittings shall be so designed and constructed that they ensure reliable mechanical protection to the cables contained therein, and shall withstand the stresses likely to occur during transport, storage and installation. They shall be marked with the marker’s name or trade mark. Marking shall be indelible and easily legible.

B. Conduits shall have a minimum 20 mm (outer diameter) size and shall be adequate for proper and easy wire pulls, and in no case shall the wires occupy a cross-sectional area of more than 30% of the inner conduit cross-section.

C. The inside and outside surfaces of conduits shall be smooth and free from burrs, flash, and similar defects. Thickness of wall shall be uniform.

D. The interior and ends of conduit fittings shall have no sharp edges; surface and corners over which the cables are likely to be drawn shall be smooth and well rounded.

E. Conduits and fittings shall have adequate mechanical strength. Conduit when bent or compressed, or exposed to impact or extreme temperatures, either during or after installation, shall show no cracks and shall not be deformed to such an extent that of the cables are likely to be damaged while being drawn in.

F. Conduit entries of fittings shall be so designed that a reliable joint can be made between the conduit and the fittings.

G. Conduits and fittings shall be BS tested or approved equal.

H. All accessories and fittings such as bends, straps, double straps, junction boxes, bushes, etc. shall be provided as required.

2.2 CONDUITS – METALLIC

A. Conduits shall be constructed from solid drawn mild steel, outside and inside galvanized and shall comply with BS 4568 Part 1 & 2.

B. The galvanized coat of zinc shall be of uniform thickness applied to outside and inside including the threads.

C. Each conduit shall be straight, free from blisters and other defects, cut square and taper reamed, furnished with coupling in standard lengths, and threaded each end.

D. Couplings shall be applied at one end of each conduit and color coded plastic threaded protectors to the other end. The interior threaded surface of each coupling shall be galvanized to ensure 100% galvanic protection on all surfaces.

E. The galvanised coating shall be of such quality and uniformity that a sample of the galvanised conduit will not show a fixed deposit of copper after four immersions of dips in a standard copper sulphate solution.

F. The galvanized coating on the conduit shall be sufficiently elastic to prevent cracking or flaking when a sample of finished conduit is bent 90 degrees at a minimum temperature of 15 degrees centigrade.
2.3 CONDUITS AND FITTINGS-NON-METALLIC

Non-metallic conduits shall be heavy gauge, high impact rigid PVC Type A (Metric) or Type AH (Imperial) unless otherwise indicated, having a maximum continuous service temperature of 70 degree C or more. Conduits and fittings shall comply with BS 4607: Part 2:1991.

2.4 CONDUITS - FLEXIBLE

Flexible conduit shall be constructed by square locked galvanised steel with a PVC outer covering.

2.5 BOXES – METALLIC

A. Boxes shall be constructed of cast metal as specified hereinafter.
B. Boxes shall be used for mounting wiring accessories. Boxes for installation in concrete shall be concrete tight. Shallow boxes shall not be used unless building construction is such that it is impossible to use standard depth boxes. Minimum acceptable depth for such boxes shall be 35 mm. Boxes shall have at least one adjustable lug and brass earth terminal.
C. Boxes shall be constructed of ferroalloy cad/zinc electroplated with aluminum cellulose lacquered.
D. Blank covers shall be constructed of sheet steel with gasket and stainless steel screws except for damp and wet locations.
E. In damp and wet locations blank covers shall be constructed from cast ferroalloy with gasket and stainless steel screws. Boxes shall be installed in walls such that they are fully aligned and flush with the wall surface after the plastering of walls.
F. Floor boxes shall be water tight one piece cast iron color-coated inside and out for additional corrosion resistance. Treaded steel cover shall be electro-galvanised. Boxes shall have adjusting screws.

2.6 BOXES - NON-METALLIC

A. Boxes shall be standard PVC as specified under Conduits & Fittings or phenolic material except for recess lighting outlets which shall be High Degree type.
B. High Degree type boxes shall be manufactured from Noryl, a thermoplastic with a higher softening temperature. Boxes shall withstand a 10 kg. load directly suspended at 100 oC for 24 hours. Boxes shall incorporate pillars with threaded steel inserts.
C. All boxes shall be provided with earth terminals.
3.1 INSTALLATION OF CONDUITS

A. Conduits embedded in ceiling slab, in walls and under floor shall be non-metallic type.
B. Conduits exposed above false ceiling shall be non metallic type.
C. Exposed conduits other than above false ceiling shall be rigid steel type.
D. All conduit work and plastering shall be complete before wires are pulled in unless otherwise permitted by the Engineer. Conduit shall be plugged with cork and boxes covered appropriately to avoid filling with plaster.
E. Conduit runs between outlets shall not contain more than three quarter bends or equivalent. The maximum run between two outlets shall not exceed 25 meters for straight runs and 10 meters for runs with one or more bends. Pull (draw in) boxes shall be provided otherwise whether so indicated on the Drawings or not. Location of pull boxes shall be acceptable by the Engineer.
F. Conduits shall be installed without causing any damage to the structural members.
G. All bends shall be carefully made to prevent distortion of the circular cross-section. Bends made on site in conduits shall have an inside radius of not less than nine diameters.
H. Where bends of less than nine diameters are necessary, standard factory elbows shall be used: however the conduit size chosen shall be such as to permit a cable-bending radius within the factory elbow of at least eight times the cable diameter.
I. Conduits in slabs shall be installed as close to the middle of the concrete slabs as practicable without disturbing the reinforcement. The outside diameter shall not exceed one third of the slab thickness, otherwise the Sub-Contractor shall install the cable exposed on the concrete slab by approved method according to site conditions. Conduits shall be placed not closer than three diameters on centers.
J. Conduits in slabs shall be placed parallel to the main reinforcement steel in the slab.
K. Top of any conduit in slabs shall be at least 2 cm below the finishes floor surface, unless otherwise indicated or authorized.
L. Conduits in slabs running parallel to beam axis shall not run above beams.

3.2 EXPOSED CONDUITS

A. Exposed conduits shall be installed parallel or at right angles to walls and ceiling beams. All changes in direction shall be made as far as possible with approved bends, elbows, and pull boxes. The spacing between parallel runs shall be uniform throughout. Unless otherwise indicated conduits shall be held securely in place by standard factory spacer bar saddles, spaced not more than 1.5, 2.0 and 2.4 meters for 20mm, 25mm and 32mm and larger conduit sizes respectively for metallic conduits and at 1 meter for non-metallic conduits.
B. Unless otherwise indicated, raceways exposed above false ceilings shall be supported from the slab above the ceiling in the same manner as exposed raceways. Raceways shall not be supported from false ceiling supports.

C. Couplings, expansion couplings, strap saddles, spacer bar saddles, spring clip saddles, conduit clips, adaptors, etc. shall all be standard factory conduit accessories.

D. Flexible metallic conduits shall be used only for connections to motors, or to other equipment subject to vibration or adjustment. Each connection shall contain at least one quarter bend so that no vibration can be transmitted behind the flexible connection. Flexible PVC conduits shall be used to make connections to lighting fixtures in false ceiling.

E. In damp and wet locations all couplings, expansion coupling, strap saddles; spacer bar saddles, spring clip saddles, conduits clips, screws, adaptors shall be corrosion proof, approved for use in damp and wet locations.

F. In damp and wet locations flexible conduits shall be liquid tight.

G. In damp and wet locations the entire conduiting system, including boxes, fittings, panel boards etc.. shall be mounted so that there is at least 7 mm air space between it and the wall supporting surface.

H. All conduits shall be carefully cleaned before and after installation. All ends shall be reamed free from burrs, and inside surfaces shall be free from all imperfections likely to injure the cable.

I. After installations of each complete new conduit run, the run shall be snaked with a band to which shall be attached an acceptable tube cleaner equipped with an acceptable cylindrical mandrel of a diameter not less than 85 percent of the nominal diameter of the conduit. All conduits through which the mandrel will not pass shall be removed and replaced by the Contractor at his own expense.

J. All field cuts in conduits shall be square, and cut ends shall be filed and shall have burrs removed. An insulating bushing shall be installed on each end of conduit, unless the connector is designed to prevent contact with the cut end. All connections shall be mechanically strong and tight, and made up properly with acceptable connectors. No running threads shall be permitted.

K. Conduits for TV system shall have at least 10 cm bending radius. Two bends might be necessary for the transition from floor to wall.

L. All exposed GI conduits shall have identification bands and labels.

3.3 INSTALLATION OF BOXES

A. Boxes of ample capacity shall be provided at every junction of conduit system and as required by the Specifications.

B. All boxes shall be securely fastened.

C. Blank plates shall be installed on outlet boxes in which no apparatus is installed, or the apparatus installed does not provide a suitable cover for box.
D. Device boxes shall be used for all wiring devices.

E. Non-metallic junction/pull boxes shall be used only for concealed conduit work, and for conduit work above false ceiling.

F. Exposed boxes for switches, socket outlets and other devices shall be cast metal boxes.

G. Cast metal boxes shall be installed in such a manner that the conduit connections and the gasket covers are dust-tight. All unused openings shall be closed with pipe plugs and compound.

H. Boxes for similar equipment shall be mounted at uniform height within the same or similar area. Mounting shall be as shown on the Drawings.

I. Device box shapes and sizes shall be determined by the type and size of wiring devices for which they serve.

J. Boxes fixed inside false ceiling shall be provided with mounting brackets for rigid fixing to structure members or other means of support.

K. All kinds of exposed pull boxes shall be painted in color relevant to the associated exposed conduits and circuit reference shall be painted on the same.

3.4 SLEEVES

A. Sleeves shall be provided for exposed conduit or cables passing through floor slabs and walls. All openings shall be sealed with mastic compound. The compound shall not cause any corrosion or harmful effects to the conduit. Sleeves passing through floor slabs shall be flush with the bottom of the slab, shall extend approximately 3cm above the surface of the floor and be watertight between sleeves and floor slab.

B. Sleeves passing through exterior walls and slabs shall be wall entrance seals of watertight construction. They shall be watertight between slab and sleeve, and between sleeve and conduit and cable. These wall entrance seals shall be of malleable iron with black paint finish and PVC sleeve, with a watertight sealing gland.

C. Sealing gland design shall be such that they may be tightened any time after installation. Wall entrance seals shall have oversized sleeves of proper length to position the sealing-gland housing with the wall faces.

D. After the cable has been pulled through the duct, a seal shall be made around it within the duct with a bituminous mastic compound, making the seal watertight.

3.5 ADHESIVES AND JOINTS

A. Conduits shall be jointed and terminated utilising the appropriate components as supplied by the conduit manufacturer.

B. Permanent adhesives to produce a rigid watertight joint shall be used with standard couplers and accessories.

C. A flexible (non-hardening) adhesive shall be used where expansion capability is required.
3.6 EXPANSION JOINTS

Expansion coupling shall be provided at every 6 meter run of exposed conduit work, at expansion joints or as required to compensate for thermal expansion and contraction of both exposed and embedded conduits.

End of Section 26 05 33
# SPECIFICATION SECTION 26 05 34
## CABLE TRUNKING (RACEWAY)

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PART 1 – GENERAL

1.1 GENERAL INSTRUCTION
Works under this section shall be governed by conditions of contract.

1.2 SCOPE
A. The Contractor shall supply and install trunking for cabling as shown on the drawings and as herein specified. The system shall include, but not limited to standard rectangular trunking sections, bends, terminations, conversions, reducers, offsets, risers and all necessary parts to install a complete trunking system.
B. Manufacturer's standard fittings shall be used for all connections and changes in directions. Cutting and bending trunking to form flanges and attachments will not be permitted.
C. Standard lengths of trunking used shall not be less than two meters.
D. Cable retaining straps shall be fitted at intervals not exceeding 1 meter.
E. Where trunking passes through walls, floors, and ceilings, non combustible, non-metallic fire barriers shall be installed in the trunking.
F. Contractor shall re-verify the trunking sizes indicated on the drawings and shall modify the same, if required, to allow the required wiring with a space factor of 45 per cent.

1.3 CODES & STANDARDS
A. Metal trunking shall be manufactured generally in accordance with the requirements of BS 4678: Part 1. Metal thickness for body and cover material shall be at least as stipulated in Table 1 of BS 4678.
B. Trunking and connectors for internal use shall be finished with class 1 protection in accordance with BS 4678: Part 1. Where used externally, protection shall be class 3.
C. Inc coating shall comply BS 729 or BS 3382: Part 2. Trunking shall be bonded to earth at several point connections, as required.
D. Construction of PVC trunking and its accessories shall comply with BS 4678: Part 4.

1.4 APPROVED MANUFACTURERS
A. Cable trunking shall be manufactured by one of the following manufacturers or approved equal as listed in the Electrical Manufacturer’s List:-
   1. Metallic Trunking
      - MK-EGA (UK)
      - Wiremold (USA)
      - Barton (UK)
   2. PVC. Trunking
      - MK-EGA (UK)
      - Decoduct (UAE)
      - Marshall Tufflex (UK)
PART 2 - PRODUCT

2.1 METAL TRUNKING

A. Metal trunking shall be manufactured in accordance with the requirements of the codes and standard mentioned above. The metal thickness shall be at least as stipulated in table 1 of BS 4678.

B. Lengths of trunking shall be bonded to each other by using strip copper links not less than 12 mm wide x 1.5 mm thick and fixed with brass nuts, bolts and serrated washers. Lids shall be fixed at intervals not exceeding 1 meter by using quick release cam type fasteners. Steel screws and fasteners shall be protected against corrosion by a finish at least equivalent to zinc coating.

C. Vertical trunking shall be supplied with cable support unit with insulated pins at intervals not exceeding 3 meter.

D. Horizontal trunking sizes exceeding 100 mm x 50 mm shall be supplied with cable separators with insulated pins at intervals not exceeding 2 meters.

E. All burrs rough edges caused due to any cutting or damage during erection shall be removed and the finish shall be made good. Corrosion patches if any, caused during storage and erection shall be removed and the affected area shall be treated with rust-proofing agent. Zinc rich epoxy primer of equivalent alternative shall be applied on the treated surfaces. In case of class 2 finishes this shall be followed by a coat of color matching paint.

F. Any fixing used for securing or fitting shall not cause any long term corrosion or electrolytic action. Where brackets are used, they shall be constructed of mild steel angle or channel iron finished to the same standard as the trunking.

G. Connections to conduit, switchgear, junction boxes and distribution boards shall be made with flanged units.

H. A trunking joint shall be made where a trunking crosses an expansion joints.

I. The earth continuity links across such joints shall be of braided copper tape not less than 15 mm wide x 2 mm thick having a resistance from fixing to fixing equal to or less than the links used for standard trunking joints.

2.2 PVC TRUNKING

A. Trunking shall be made from high impact rigid PVC of thickness not less than 1.5 mm. Concealed trunking shall be of medium classification (IP42) and surface trunking shall be of heavy classification (IP53).

B. Lids shall be of the clip on type construction. All trunking accessories shall be of the same manufacturer. Site fabricated accessories shall not be acceptable.

C. Where the trunking is installed in ambient conditions higher than 25 degrees centigrade, trunking joints shall accommodate 7 mm expansion for every 6 meters of trunking run.

D. Protective conductor of not less than 2.5 mm2 with green and yellow insulation shall be installed throughout the length of the trunking, to allow looping in and out of metallic equipment and accessories.
2.3 SKIRTING TRUNKING

A. Unless otherwise specified elsewhere, the trunking shall have three compartments one for power cables and the other for telephone and low current wires, as detailed on the Drawings.

B. Trunking body shall be manufactured from 1.2 mm nominal thickness zinc coated sheet steel in standard 2 meter lengths, with spot welded partition, each length supplied with one back connecting plate, one earthing strap, with plated mushrooms head steel screws and shake proof washers. The cover fixings are secured by an internal fixing bridge and external fixing strap, both of which are mobile down the length of skirting to any given position, the covers shall be cut to suit on site. Metal work shall be finished metallic silver enamel inside and outside to receive site painters finished coat.

C. Skirting trunking shall have enough space for standard power socket outlets and telephone or data outlets both being screened and totally enclosed by sheet metal.

D. Skirting trunking elbows shall be easily installed wherever necessary on site. Similarly power socket outlets and telephone outlets shall be inserted at any place on the trunking with the same ease.

2.4 DADO TRUNKING

A. Dado trunking shall be manufactured from a minimum of 1.6 mm galvanised mild steel with .0001 mm zinc deposit and approved finished epoxy coated. Cover shall be of minimum 1.2 mm galvanised steel.

B. Fittings shall be manufactured from the same steel as body and covers with epoxy coated and matching color. Socket/switch socket plates shall be provided as one or two gangs as required. Connector blocks with four pinching screws shall be provided as required.

C. Dado trunking shall have provision for compartment when used for power, low current and telephone / data system distribution.
3.1 SUPPORTS

A. Trunking when run horizontally shall be securely supported at intervals not exceeding 1.5m, unless specially approved for supports at greater intervals, but in no case shall the distance exceed 3 m.

B. Trunking when run vertically shall be securely supported at intervals not exceeding 4.5 m and shall have not more than one joint between supports.

3.2 INSTALLATION

A. Trunking shall be securely fixed to floors, walls, ceiling or multi beam trunk to the approval of the Engineer. It shall be installed such that it shall not be obstructed by other trades. Adjoining sections shall be securely fastened together to provide a rigid joint.

B. The sum of cross-sectional areas of all contained conductors shall not exceed 20% of the interior cross-sectional area of the trunking.

C. Trunking shall include all necessary cable retainers. Runs of trunking shall be parallel or perpendicular to walls and partitions.

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# SPECIFICATION SECTION 26 05 36
## CABLE TRAYS
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1.1 GENERAL INSTRUCTIONS

Works under this section shall governed by conditions of contract and section of division.

1.2 SCOPE

A. Cable trays shall be installed either indoors or outdoors or described herein or as shown on the drawings and as directed by and acceptable to the Engineer.

B. All accessories used in the cable trays system such as bends, intersections risers, reducers shall be the product of the same manufacturer as that of the cable tray. Site fabricated accessories are not acceptable.

1.3 APPLICABLE STANDARDS

A. Specification for cable trays - BSEN 10130, BSEN 10131 and BSEN 10151 as appropriate.

B. Specification for Hot Dip Galvanization - BS 729.

1.4 APPROVED MANUFACTURERS

A. The proposed cable trays / ladders shall be manufactured by one of the following makes or approved equal, as listed in the “Electrical Manufacturers List”.

1. Swifts (UK)
2. Ductile Sections (UK)
3. Wallsall (UK)
PART 2 - PRODUCT

2.1 GENERAL

Cable trays shall be manufactured from cold rolled mild steel to comply with BS 5750/BSEN 10130/BSEN10131/BSEN10051 as applicable. Cable trays shall have a perforated construction. All accessories used such as bends, intersections, risers, reducers, etc, used in cable tray installation shall be of the same manufacturer as that of the cable tray.

2.2 MATERIALS

A. The thickness of cable tray for normal application shall comply with the following requirements:

<table>
<thead>
<tr>
<th>Width of Tray</th>
<th>Min. thickness</th>
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<tbody>
<tr>
<td>Upto and including 229 mm</td>
<td>1.0 mm</td>
</tr>
<tr>
<td>Above 229 mm upto and including 305 m</td>
<td>1.2 mm</td>
</tr>
<tr>
<td>Above 305 mm upto and including 457 mm</td>
<td>1.5 mm</td>
</tr>
<tr>
<td>Above 457 mm upto and including 914 mm</td>
<td>2.0 mm</td>
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B. For heavy duty application or in applications where the span between supports and loading of cables necessitates, heavy duty cable trays shall be used. The thickness of heavy duty cable tray and its accessories shall comply with the following requirements:

<table>
<thead>
<tr>
<th>Width of Tray</th>
<th>Min. thickness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upto and including 457 mm</td>
<td>1.5 mm</td>
</tr>
<tr>
<td>Above 457 mm upto and including 914 mm</td>
<td>2.0 mm</td>
</tr>
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</table>

C. Heavy duty cable trays shall be manufactured with plain return flanges.

D. Unless otherwise specified, the sub-contractor shall be responsible for selection of the correct grade of cable tray to meet the site conditions and the requirements of these specifications.

E. Cable tray and its accessories shall have a hot-dip galvanized finish to BS 729. Any damage caused to the tray during installation and/or storage, shall be repaired by using zinc rich epoxy primer or equal alternative, followed by a generous existing metal coating. The joining bolts, nuts and washer shall be of galvanized steel. Brass shall not be used.
PART 3 - EXECUTION

3.1 Joining of various sections of the cable tray and its accessories shall be done in accordance with the recommendations of the manufacturer, or alternatively by using rustproof mushroom head roofing bolts, nuts and washers.

3.2 Where necessary, the cutting line of the cable tray shall be through continuous metal parts and not through the perforations. Burrs or sharp edges shall be removed prior to installation of tray sections and accessories.

3.3 Fixing and supports shall be installed at regular intervals of 1200 mm and not more than 150 mm from all bends, tees, intersections and risers. Mid span joints between cable tray sections shall be avoided. Joints shall be positioned as close as practicable to the cable tray supports.

3.4 Where necessary, the cutting line of the cable tray shall be through continuous metal parts and not through the perforations. Burrs or sharp edges shall be removed prior to installation of tray sections and accessories.

3.5 A minimum clear space of 25 mm shall be kept behind all installed runs of cable tray. Cables shall be installed in the trays in a single layer leaving 25 percent spare space on the tray for future use.

3.6 Cable trays shall provide direct support to the cables without cleats or saddles wherever practicable. Purpose made straps, cleats or saddles shall however be used to maintain a neat or regular disposition of cables. In vertical tray installation or where trays do not directly support the cables, load bearing cable cleats or saddles shall be employed and securely fixed to the tray. Manufacturer’s recommendations shall be followed in selection of cable cleats or saddles, on the basis of individual application.

3.7 Electromechanical continuity shall be maintained throughout the run of cable trays. Trays carrying LV cables shall be bonded to earth with green/yellow PVC insulated single core stranded copper cable. Trays carrying HV cables shall be bonded to earth with copper strip.

3.8 HV and LV cables shall be installed on separate cable trays.

3.9 Un-served MIC cables shall not be installed on galvanized cable tray.

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PART 1 – GENERAL

1.1 GENERAL INSTRUCTIONS
Works under this section shall be governed by Conditions of Contract.

1.2 SCOPE
The contractor shall supply, install, test and commission Sub-main Distribution Boards complete as herein specified and as shown on the drawings, consisting of voltmeters, ammeters and instrument transformers where required and as indicated in the schematic diagrams.

1.3 CODES AND STANDARDS
A. Sub-main Distribution Board shall conform to BSEN 60439-1:1994.
B. Cabinet color shall conform to BS381C.
C. Moulded case circuit breaker shall conform to IEC-439-1 (EN 60439-1)
D. Requirements for type tested or - BSEN 60439-1 1994
E. partially type tested assemblies EN 60898
G. Circuit breakers shall be UL listed and meet NEMA Standard No. AB1-1975, and Federal Specification W-C-375B/GEN where applicable.

1.4 APPROVED MANUFACTURERS
A. Sub-main distribution boards shall be manufactured one of the following manufacturers or approved equal as listed in the Electrical Manufacturers List:-
   1. Merlin Gerin (France)
   2. ABB (Europe)
   3. Dorman – Smith (UK)
2.1 CABINETS AND FRONTS

A. Distribution board assembly shall be enclosed in a steel cabinet. Cabinet shall be of sufficient size to provide a minimum gutter space of 10 cm on all sides. The thickness of the sheet steel shall be minimum 1.5 mm.

B. Fronts shall include doors and have flush, brushed stainless steel cylinder tumbler type locks with catches and spring loaded door pulls. The flush lock shall not protrude beyond the front of the adjustable indicating trim clamps which shall be completely concealed when the doors are closed. Fronts shall have approved directories with name of panel, number of phases, wires and voltage written on them. Doors shall be mounted by completely concealed steel hinges. Fronts shall not be removable with door in the locked position. A Circuit directory card shall provide a space of at least 0.8 cm high x 7 cm long or equivalent for each circuit.

C. The directory shall be typed to identify the load fed by each circuit.

D. Fronts shall be of powder coated electro galvanized sheet steel. Color shall be grey or acceptable equal.

E. Joints shall be welded, galvanized and reinforced where necessary and galvanized after fabrication.

2.2 SUB-MAIN DISTRIBUTION BOARD BUS ASSEMBLY

A. Bus for connections to the branch circuit breakers shall be the "Distributed Phase" or "Phase Sequence" Type.

B. Three-phase, four-wire bussing shall be such that any three adjacent single-pole breakers are individually connected to each of the three different phases in such a manner that two or three pole breakers can be installed at any location. All current carrying parts of the bus assembly shall be plated.

C. Main and neutral buses shall be minimum 98% conductivity rectangular copper bars, provided with bolted-type lugs as necessary.

D. Buses shall be rigidly supported and insulated and be so designed that branch circuits can be removed without disturbing adjacent units or changed without additional machining, drilling or tapping.

E. Necessary bussing, drilling and blank plates shall be provided for installation of future circuits when so indicated in the Schedules on the Drawings.

F. All screws and bolts used for making copper connections shall be equipped with lock washers. Riveted connections will not be acceptable.

G. Mains shall be equipped with solder less pressure indent type connectors and shall have means to prevent swiveling of connector.

H. Neutral bus bars shall be full size and shall incorporate one neutral terminal for each single pole and neutral way.

I. Aluminum shall not be used for any interior panel board parts.
J. Back pan or mounting on which buses and branches are mounted shall be rigid to properly support the component parts.

K. Reinforcing of back pan shall be by flanging or addition of angle iron.

L. Buses, connectors, and terminals shall be silver plated to a minimum thickness of 0.1mm.

M. Sub-main Distribution Board shall be equipped with thermal magnetic type moulded case circuit breakers of frame size and trip ratings as indicated on the drawings.

N. The bus bar structure and the main breaker shall have current ratings as shown on the drawings. The main incomer shall be either an automatic or non-automatic moulded case circuit breaker as indicated on the drawings.

O. Sub-main Distribution Board shall have, 415 V, 3-phase, 50 Hz duty rating and shall have short circuit interrupting capacity equal to or greater than the integrated equipment rating shown on the drawings.

2.3 MOULDED CASE CIRCUIT BREAKERS

A. Moulded case circuit breakers shall have trip settings, and number of poles, as indicated on the Drawings. All circuit breakers shall have their ampere trip rating clearly marked and visible.

B. Breakers shall have quick-make, quick-break, toggle mechanisms; and shall provide positive trip-free operation on abnormal overloads. Stationary and movable contacts shall be adequately protected with effective and rapid arc interruption. Each pole of the breaker shall be equipped with an inverse time delay thermal over current trip element and magnetic instantaneous over current trip elements for common tripping of all poles for multiple breakers. Multiple pole breakers shall have a single handle mechanism. Automatic tripping shall be indicated by the breaker handle assuming a clearly distinctive position from the manual ON and OFF position.

C. Circuit breakers shall have minimum RMS symmetrical interrupting capacities at 380 V equal to the values indicated below for moulded case circuit breakers unless otherwise indicated, and shall in no case be less than the bus bar short circuit bracing of the distribution board:

D. 25kA up to 150A frame size 35kA for 225A frame size and above.

2.4 CURRENT LIMITING CIRCUIT BREAKERS

A. Current limiting circuit breakers shall have a maximum interrupting rating of 100 KA rms symmetrical amperes.

B. Current limiting circuit breakers shall be supplied in unit molded case construction and shall consist of a common trip, thermal magnetic circuit breaker with an independently operating limiter section in series with each pole.

C. The conventional breaker section shall have an over center, trip-free toggle-type mechanism with quick make, quick break action and positive handle indication. A button shall be provided on the cover for mechanically tripping the circuit breaker. The current limiting breaker shall have permanent trip units containing individual thermal and magnetic trip elements in each pole. The thermal trip element shall be calibrated for 50°C ambient temperature.

D. The limiter section shall consist of three current limiting elements electrically coordinated with the conventional circuit breaker trip elements. The contacts of the limiter section shall
be electro-magnetically and electro-dynamically opened and held open until interruption is complete. The unit shall not contain replaceable elements and the limiter shall automatically reset after circuit interruption.

E. On high level fault currents the limiter portion of the circuit breaker shall operate to limit the rise of fault current. Integral resistance shall be introduced into faulted circuit to dissipate and limit let-through energy and to provide a voltage transient-free interruption at rear unity power factor.

F. The current limiting circuit breaker shall have front removable lugs. Lugs shall be UL listed for copper conductors.
PART 3 - EXECUTION

3.1 SUB-MAIN DISTRIBUTION BOARD INSTALLATION

A. Sub-main distribution board shall be aligned, leveled and securely fastened to the building, substrata.

B. Connecting conduits shall not be used to support the distribution board.

C. All unused openings in Sub-main distribution board cabinets shall be properly closed.

D. Sub-main distribution board interiors shall not be installed in cabinets until all conduit connections to the cabinet have been completed.

E. Trim shall be installed plumb and square to the enclosure finish.

F. Trim for flush mounted cabinets shall be installed in plaster frame, flush with finished wall.

G. Concealed surfaces of cabinets shall be given on site a heavy application of emulsified asphalt prior to installation.

H. Free standing sub-main distribution boards when installed in electrical closets, or rooms with raised floors shall be provided with galvanized steel support structures to raise the level of the panel to 10 cm above the original floor level.

3.2 EARTHING

A. An acceptable terminal bar for equipment earthing conductors shall be provided with minimum number of cable terminations equal to the single pole number of ways of the panel board.

B. Cabinets shall be provided with an earth connector welded to it.

End of Section 26 24 14
SPECIFICATION SECTION 26 24 16

DISTRIBUTION BOARDS

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PART 3  EXECUTION
3.1  Distribution Board Installation
3.2  Earthing
1.1 GENERAL INSTRUCTIONS
Works under this section shall be governed by Conditions of Contract.

1.2 SCOPE
The Contractor shall supply and install the distribution boards (DB, EDB) as indicated in the Schedules, where shown on the Drawings, and as herein specified. They shall include bus assembly, cabinet and front, circuit breakers and all necessary parts to install complete distribution boards.

1.3 CODES AND STANDARDS
A. Distribution boards shall conform to BSEN 60439-1:1994 and EN 60898.
B. Color shall be gray to ANSI No. 61, BS 381 C or approved equal.
C. Miniature circuit breakers shall have tripping characteristics in accordance with EN 60898 in an ambient temperature of 40 deg. C.
D. Requirements for type tested or - BSEN 60439-1 1994 partially type tested assemblies - EN 60898

1.4 APPROVED MANUFACTURERS
A. Distribution Boards shall be manufactured by one of the following manufacturers or approved equal as listed in the Electrical Manufacturer’s List:-
   1. Merlin- Gerin (France)
   2. ABB (Europe)
   3. Dorman Smith (UK)

1.5 SHOP DRAWINGS
The Contractor shall submit shop drawings for the switchboards including schematic diagrams with all protective devices, control, instruments and instrument transformers details, dimensions of the assembly, etc. for Engineer’s review. A copy of these shop drawings shall also be submitted to the local power authorities for approval. Any modification required by the Engineer or the local power authorities to allow the equipment to comply with the codes, standards and specifications called for hereinbefore shall be carried out without additional charges.
2.1 CABINETS AND FRONTS

A. The distribution board bus assembly shall be enclosed in a galvanised sheet steel cabinet. Cabinet shall be of sufficient size to provide a minimum gutter space of 10 cm on all sides. The thickness of the sheet steel shall be minimum 1.5 mm.

B. Fronts shall include doors and have flush, brushed stainless steel cylinder tumbler-type locks with catches and spring loaded door pulls. The flush lock shall not protrude beyond the front of the door. All distribution board locks shall be keyed alike. Fronts shall have adjustable indicating trim clamps which shall be completely concealed when the doors are closed. Fronts shall have approved directories with name of panel, number of phases, wires and voltage written on them.

C. Doors shall be mounted by completely concealed steel hinges. Fronts shall not be removable with door in the locked position. A circuit directory card shall provide a space at least 0.5 cm high x 7 cm long or equivalent for each circuit.

D. The directory card shall be typed to identify the load fed by each circuit.

E. Fronts shall be of code gauge, full finished steel with rust-inhibiting primer and baked enamel finish.

F. Joints shall be welded, galvanised and reinforced where necessary and galvanised after fabrication.

2.2 DISTRIBUTION BOARD BUS ASSEMBLY

A. Bus for connections to the branch circuit breakers shall be the "Distributed Phase" or "Phase Sequence" Type.

B. Three-phase, four-wire bussing shall be such that any three adjacent single-pole breakers are individually connected to each of the three different phases in such a manner that two or three pole breakers can be installed at any location. All current carrying parts of the bus assembly shall be plated.

C. Main and neutral buses shall be minimum 98 percent purity, rectangular copper bars, provided with bolted-type lugs as necessary.

D. Buses of miniature circuit breaker distribution boards shall be suitably braced for a minimum short circuit duty equal to 10,000 Amps unless otherwise indicated.

E. Buses shall be rigidly supported and insulated and be so designed that branch circuits can be removed without disturbing adjacent units or changed without additional machining, drilling or tapping.

F. Necessary bussing, drilling and blank plates shall be provided for installation of future circuits when so indicated in the Schedules on the Drawings.

G. All screws and bolts used for making copper connections shall be equipped with lock washers. Riveted connections will not be acceptable.

H. Mains shall be equipped with solder less pressure indent type connectors and have means to prevent swivelling of connector.
I. Neutral terminal strip shall be full size and shall incorporate one neutral terminal for each single pole and neutral way.

J. Aluminum shall not be used for any interior parts of the distribution board.

K. Back pan or mounting on which buses and branches are mounted shall be rigid to properly support the component parts.

L. Reinforcing of back pan shall be by flanging or addition of angle iron.

M. Buses, connectors, and terminals shall be silver plated to a minimum thickness of 0.1 mm.

N. Distribution boards shall be factory assembled.

O. Distribution boards shall be of a dead-front safety type, equipped with protective devices as shown on the Schedules.

P. Distribution boards shall have 415 V volt duty rating, with other ratings as shown on the Drawings.

Q. Distribution boards circuit numbering shall be such that, starting at the top, odd number shall be used in sequence down the left-hand side and even numbers shall be used in sequence down the right-hand side.

R. Distribution boards shall incorporate plug-in type miniature circuit breakers of tripping characteristics B, C or D for lighting, miscellaneous power or motor loads as necessary complete as specified and as shown on the drawings and to the acceptance of Engineer.

S. Main breakers of all main breaker type distribution boards shall be plug in type miniature circuit breaker or bolt-on moulded case type circuit breaker as shown on the drawings.

2.3 SPLIT BUS DISTRIBUTION BOARDS

A. Split bus distribution board shall incorporate a main switch or circuit breaker for the entire distribution board and two or more sub-main earth leakage circuit breakers that shall protect each section of the distribution board circuits against earth leakage.

B. For the wiring of circuits consisting of wire sizes 10 mm² and larger shall be of the bolted pressure type, with a pre-insulated sleeve.

C. Connectors shall be manufactured from high conductivity copper, electro tin-plated.

2.4 CIRCUIT BREAKERS

A. All plug-in type and bolt-on moulded case circuit breakers shall have trip settings, and number of poles, as indicated on the Drawings. All circuit breakers shall have their ampere trip rating clearly marked and visible.

B. Breakers shall have quick-make, quick-break, toggle mechanism and shall provide positive trip-free operation on abnormal overloads. Stationary and movable contacts shall be adequately protected with effective and rapid arc interruption. Each pole of the breaker shall be equipped with an inverse time delay thermal over current trip element and magnetic instantaneous over current trip elements for common tripping of all poles for multiple breakers. Multiple pole breakers shall have a single handle mechanism.

C. Automatic tripping shall be indicated by the breaker handle assuming a clearly distinctive position from the manual ON and OFF position.

D. Circuit breakers shall have minimum RMS symmetrical interrupting capacities equal to 10,000 Amps at 380 V for miniature circuit breakers and capacities equal to the values
indicated in the drawings for moulded case circuit breakers but shall in no case be less than the bus bar short circuit bracing of the distribution board.

E. Moulded case circuit breakers shall have frame sizes equal to or greater than their trip ratings unless otherwise indicated and shall be suitable for operation at an ambient temperature of 50 degree C.

2.5 CURRENT LIMITING CIRCUIT BREAKERS

A. Current limiting circuit breakers shall have a maximum interrupting rating of 100 KA rms symmetrical amperes.

B. Current limiting circuit breakers shall be supplied in unit molded case construction and shall consist of a common trip, thermal magnetic circuit breaker with an independently operating limiter section in series with each pole.

C. The conventional breaker section shall have an over centre, trip-free toggle-type mechanism with quick make, quick break action and positive handle indication. A button shall be provided on the cover for mechanically tripping the circuit breaker. The current limiting breaker shall have permanent trip units containing individual thermal and magnetic trip elements in each pole. The thermal trip element shall be calibrated for 50 degree C ambient temperature.

D. The limiter section shall consist of three current limiting elements electrically co-ordinated with the conventional circuit breaker trip elements. The contacts of the limiter section shall be electro-magnetically and electro-dynamically opened and held open until interruption is complete. The unit shall not contain replaceable elements and the limiter shall automatically reset after circuit interruption.

E. On high level fault currents the limiter portion of the circuit breaker shall operate to limit the rise of fault current. Integral resistance shall be introduced into faulted circuit to dissipate and limit let-through energy and to provide a voltage transient-free interruption at near unity power factor.

F. The current limiting circuit breaker shall have front removable lugs. Lugs shall be UL listed for copper conductors.

2.6 EARTH LEAKAGE CIRCUIT BREAKERS

A. Each leakage circuit breakers shall be current operated type providing protection against overloads, short circuit, and low level earth faults of 30 mA, 100 mA or 300 mA as applicable or as shown on the drawings.

B. It shall fit in standard distribution boards.

C. A push-to-test mechanism shall be provided to ensure proper operation.

D. Enclosure shall be glass fiber reinforced, plastic (GRP) construction.

E. Breaker shall have 6000A interrupting capacity unless otherwise indicated.

F. Breaker shall in other respects be similar to miniature circuit breakers.
PART 3 - EXECUTION

3.1 DISTRIBUTION BOARD INSTALLATION
A. Distribution board shall be aligned, leveled and securely fastened to the building sub-base for surface mounted application or recessed in the wall for flush mounted distribution board.
B. Connecting conduits shall not be used to support the distribution board.
C. All unused openings in distribution board cabinets shall be properly closed.
D. Distribution board interiors shall not be installed in cabinets until all conduit connections to the cabinet have been completed.
E. Trim for flush mounted cabinets shall be installed in plaster frame, flush with finished wall.
F. Trim shall be installed plumb and square to enclosure finish.
G. Concealed surfaces of cabinets shall be given on site a heavy application of emulsified asphalt prior to installation.

3.2 EARTHING
A. An acceptable terminal bar for equipment earthing conductors shall be provided with a minimum number of cable terminations equal to the single pole number of ways of the distribution board.
B. A cable connection shall be made from the earth bar to the cable gland of the incoming feeder as applicable.
C. Cabinet shall be provided with an earth connector welded to it.

End of Section 26 24 16
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PART 1 – GENERAL

1.1 GENERAL INSTRUCTIONS
Works under this section shall be governed by Conditions of Contract.

1.2 SCOPE
A. The Contractor shall supply and install all of the wiring devices as indicated on the Drawings and as herein specified.
B. Wiring devices shall be flush mounted type, unless otherwise noted and shall be installed at heights as shown on the Drawing, or as directed by the Engineer.
C. Wiring devices fixed on glazed tiles shall include a rubber gasket between the cover plate and the glazed tiles for rigid fixing of the device plates. The gaskets shall not protrude beyond the plate: they shall be neatly cut in the shape of the plate.
D. Samples of devices and plates shall be submitted for selection and acceptance of the Engineer.

1.3 APPLICABLE STANDARDS
B. Specification for 13A fused plug and socket outlets - BS 1363:1984
C. Specification for Amino plastic Moulding materials - BS 1323:1992
D. Specification for Transformers for reduced voltage - BS 3535:1990
E. Specification for Lighting Switches - BS 3676
F. Specification for Dimmers - BS 5548.

1.4 APPROVED MANUFACTURERS
Approved manufacturers for wiring devices shall be one of the following manufacturers or approved equal as listed in the Electrical Manufacturers List.
A. MK (UK)
B. Crabtree (UK)
C. Clipsal (Australia)
PART 2 - PRODUCT

2.1 DEVICE PLATES
A. Plates shall be rectangular or square in shape to the acceptance of the Engineer.
B. Plates shall be designed to match associated devices.
C. Plates for cord extension shall be provided with cord grip bushings, threaded type, of same material and finish as of plate.
D. Unless otherwise specified or indicated on the Drawings, plates for flush mounting devices shall be constructed of moulded material of ivory or white in color in general areas.
E. Fixing screws shall be chromium plated and polished. Screw heads shall be finished to suit the plates.

2.2 SWITCHES
A. Switches shall be rocker operated mounted with the operating handle in the upward position when in the "ON" position unless otherwise directed by the Engineer.
B. Switches shall interrupt the hot wire or hot and neutral simultaneously as applicable.
C. Switches shall be quick-make, quick-break, with silver alloy contacts, trunnions and spring assembly lubricated for the life of the switch neoprene bumpers.
D. Switches shall be 250 volt ac only rated with number of poles and amp ratings as indicated on the Drawings, to BS 3676 Part 1.
E. Switches shall be fully rated for tungsten filament and fluorescent lamp loads, and up to 80% of rated capacity for motor loads.
F. Lighting switches shall be as manufactured by MK (UK), Crabtree (UK), or acceptable equal.
G. Switches shall be one gang or multigang, 1-way, 2-way or intermediate as indicated on the drawings and to the acceptance of the Engineer.
H. Key operated lighting switch shall be 20 amp rated, one way single pole, similar to MK 4898, Crabtree 4451 to the acceptance of the Engineer.
I. 20-Amp double pole switches shall incorporate a pilot light, and shall have the words "Water Heater" engraved on it when used for that purpose.
J. 20-Amp double pole switches shall be similar to MK 5423, 5423/WH Crabtree 4015/3, 4015/31 to the acceptance of the Engineer.
K. 32 Amp double pole switches shall be similar to MK 5105/WH1 or Crabtree 4013/3, to the acceptance of the Engineer.
L. 30-Amp double pole switch shall incorporate the inscription indicating the purpose of its use.
M. 45/50-Amp double pole switches shall incorporate a pilot light, and shall have the word "Cooker" engraved on it when used for that purpose.
N. 45/50-Amp double pole switches shall be similar to MK 5215/WH1, Crabtree 4500/3, 4500/31 to the acceptance of the Engineer.
2.3 SWITCH PANELS

A. Switch panels shall be of the grid switch system, comprising rocker-operated grid switches and cover plates of moulded material with white finish, unless otherwise indicated.

B. Switch panels shall comprise 20-amp lighting switches, and other units if so indicated on the Drawings.

C. Switches shall be similar to MK 4891, 2, 3, Crabtree 4450, 4550, 4552&4535 to the acceptance of the Engineer.

D. Switch panels shall have the words "Danger 415 volts" engraved in red in it.

E. Cover plates shall be similar to MK 3631, 2, 3, 4, 6 & 8 Crabtree 5571, 2,3,4,6 unless otherwise specified or indicated on the Drawings, to the acceptance of the Engineer.

2.4 TIMER SWITCHES

Timer switches shall be 20-amp rated, one pole, one throw with one "OFF" and one "ON" levers. Switch shall be 30 minute dial type, recess mounted. Switches shall have 20,000 switching cycles guaranteed life.

2.5 LIGHTING CONTACTOR CONTROL PUSHBUTTONS

A. Pushbuttons shall be double contact type with spring return action.

B. Body shall be made of molded plastic with clear baked acrylic protection.

2.6 SOCKET OUTLETS

A. Socket outlets shall be mounted with correct polarity, such that switch shall cut the hot wire.

B. Socket outlets shall be of the standard, 3-pin, switched, single phase, shuttered type of moulded plastic unless otherwise specified.

C. 13-amp socket outlets shall be flat pin type, to BS 1363, single or twin as indicated.

D. 13-amp socket outlets shall be similar to MK 2757WH1, 2747WH1, Crabtree 4304, 4306 unless otherwise specified or indicated on the Drawings, to the acceptance of the Engineer.

E. 15-amp socket shall be round pin switched type to BS 546.

F. 5 Amp.socket shall be round pin type similar to MK 2891 WH1, Crabtree 2330 to the acceptance of the Engineer.

G. 15-amp socket shall be similar to MK 2893WH1, Crabtree 2382 to the acceptance of the Engineer.

H. 30-amp sockets shall be round pin type, cover made of brass and shall be provided with corresponding plugs.

I. 30-amp sockets shall be similar to Walsall 0.166 A11 or acceptable equal.

2.7 PROTECTIVE SOCKET COVER

A. Weatherproof socket outlets shall be provided with protective socket covers.

B. Protective socket cover shall be manufactured from high impact resistant "Noryl". The cover shall be designed to fall by gravity over the socket whether a plug is inserted or not.

C. Cover shall be similar to Egatube "Guardian" to the acceptance of the Engineer.
2.8 CEILING ROSES
A. Ceiling roses shall be designed to meet the requirements for the installation of flexible pendent cords for lighting. They shall be moulded in a non-track insulating material to BS 1323 and shall comply with BS 67 and IEE Wiring Regulations.
B. Ceiling roses shall incorporate 3 terminals (one of which properly shrouded), loop-in, earth and strain. The shrouded terminal shall be used for the live un switched wires.
C. All lighting fixtures incorporated in a false ceiling shall be connected to the ceiling lighting outlet through a ceiling rose and a flexible cord.
D. 3 Pin ceiling roses shall include plug and socket interface and shall comply BS 6972 and BS 5733. 3 Pin ceiling roses shall be similar to MK 3240WHI/ MK 3241 WHI.

2.9 HOOK FOR CHANDELIER
Hook shall be suitable for suspension of chandeliers of up to 25 kgs, unless otherwise indicated and shall be similar to Thorn GAC 1838 or acceptable equal.

2.10 FUSED CONNECTION UNIT
A. Fused connection unit shall be surface mounting type or flush type as indicated and as applicable. The 13 Amp fused connection unit shall incorporate a double pole switch, a neon indicator and a fuse link to BS 1362 of appropriate rating. The fused connection units used for security system components shall be un switched type.
B. Switched fused connection unit shall be similar to MK 370WHI, Crabtree 4827/3, and the device box shall be similar to MK 2140 WHI, Crabtree 9047. The un switched fused connection unit shall be similar to MK 377 WHI, Crabtree 4828, all to the acceptance to the Engineer.
C. Outlet for fan coil units with heaters ceiling mounted shall be surface mounting type and shall comprise a 20-amp double pole switch for the fan motor and a 50-amp double pole switch for the heater.
D. Outlet shall be an Electricaire control unit similar to MK 5300 to the acceptance of the Engineer.
E. Outlet for fan coil units installed at low level shall be a recess mounting 13-amp fused connection unit incorporating a double pole switch, neon indicator, fuse of appropriate rating and flex outlet.
F. Outlet shall be similar to MK 370 WH1, Crabtree 4827/3 to the approval of the Engineer.
G. Outlet for fan coil units with heaters installed at low level shall be a recess mounting 25-amp twin double pole switch with two flex outlets or alternatively a 20-amp and a 50-amp two double pole switches with two flex outlets.
H. Outlet shall be similar to MK 5257, to the acceptance of the Engineer.

2.11 TELEPHONE OUTLETS
A. Telephone outlets shall be cord grip type and shall consist of terminal blocks of high insulating phenolic block with non-ferrous screws and straps.
B. Telephone outlets shall be similar to MK 4817WH1, Crabtree 7283, unless otherwise specified or indicated on the Drawings to the acceptance of the Engineer.
2.12 DOOR BELL PUSHBUTTONS
A. Pushbuttons shall be double contact type with spring return action.
B. Body shall be made of molded plastic with clear baked acrylic protection.
C. Pushbutton shall have provision for directory of names. Pushbutton shall be lighted type, similar to Legrand 40802 or acceptable equal.

2.13 TV OUTLETS
A. TV outlets shall be of molded material and shall have a low attenuation (1 db) for all frequencies.
B. TV outlets shall be supplied with matching plugs and cord of 1.2 meters.
C. TV outlets shall be manufactured by the same manufacturer of the TV System and to the acceptance of the Engineer.

2.14 CONTROL STATIONS
A. Control stations shall be spring type, with silver plated contacts. Contacts shall be 5 amp rated. Plate shall be constructed from aluminum gray baked enamel painted.
B. ON-OFF maintained contact station shall have two pushbuttons, one green for ON and one red for OFF. A green pilot light shall be incorporated which shall lit when pushbutton ON is depressed. The words ON & OFF shall be engraved on the pushbuttons in white.
C. START-STOP momentary contact type station shall have two pushbuttons, one green for START and one red for STOP. A green pilot light shall be incorporated which shall lit when pushbutton START is depressed. The word START & STOP shall be engraved on all motor control stations.
D. UP-STOP-DOWN momentary contact type stations shall have three pushbuttons and no pilot lights.
E. Pushbuttons shall be moulded from trac-resistant material and shall be provided with button shrouding ring.
F. Key switch shall be a cylinder lock operator type station with three positions UP-OFF-DOWN. These words shall be engraved on the station.
G. Stations in damp & wet locations shall be enclosed in a Ferroalloy box and covered with stainless steel plates.
H. When line voltage is 380-415 and the control is line-to-line connected as described under MOTORS & STARTERS", a warning notice shall be inscribed in the device in a clearly visible manner once the cover is removed.

2.15 FLEX-OUTLET
Flex-outlet shall be similar to MK 1090, Crabtree 4075 unless otherwise specified or indicated on the Drawings, to the acceptance of the Engineer.
2.16 CABLE OUTLET

A. Cable outlet shall comprise a moulded cover plate with a side groove for 3 x 10 mm2 multi core flexible cord, a cable clamp, 3 terminals for 10 mm2 conductors.

B. Cable outlet shall be similar to Crabtree 4506, MK 5045 to the acceptance of the Engineer.

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SPECIFICATION SECTION 26 33 53
UNINTERRUPTED POWER SUPPLY (UPS)

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PART 1 – GENERAL

1.1 GENERAL INSTRUCTIONS

Works under this section shall be governed by conditions of contract.

1.2 SCOPE

The Contractor shall supply, install, connect, commission and test the Uninterrupted Power Supply systems including but not limited to UPS unit, long life Sealed Lead Acid batteries, battery racks, battery charger, static bypass switch, terminal tapping, isolation transformer, circuit breakers, etc. complete as herein specified.

1.3 CODES AND STANDARDS

A. Design & manufacture : ISO 9001, ISO 14001, IEC 60146
B. Construction and safety : IEC 60950, EN 50091-1, IEC 62040-1
C. Protection : IEC 60521
D. EMC : IEC 62040-2, EN 50091-2 level B
E. Certification : TUV, CE
F. Performance and topologies : IEC 62040-3, EN 50091-3

1.4 APPROVED MANUFACTURERS

A. Uninterrupted power supply system shall be manufactured by one of the following manufacturers or approved equal as listed in the Electrical Manufacturers List.
   1. MGE UPS Systems (France)
   2. Liebert (UK)
   3. Chloride (UK)
B. Sealed Lead Acid Maintenance Free Batteries shall be manufactured by one of the following manufacturers:
   1. CEAG- Fulmen (France).
   2. EXCIDE (Europe).

1.5 SYSTEM OPERATION

The UPS shall be designed to operate as an on-line double conversion system in the following modes:

A. Normal:

The UPS shall deliver power to critical loads without interruption. The rectifier/charger shall draw alternating current (AC) from the mains and shall convert it into direct current (DC) for the inverter. The inverter shall convert it back into clean AC current for the load. The rectifier/charger shall also charge the battery.
B. Mains Power failure:
In the event of a mains failure, the critical loads shall be supported by the inverter with power from the battery.

C. Recharge Cycle:
When mains power has been re-instated, the rectifier/charger gains shall support the load via the inverter and shall recharge the battery.

D. Static bypass mode:
The static switch shall transfer the load to the bypass line without interrupting power to the critical loads. If the inverter needs to be shut down the loads shall be transferred back to the inverter by turning the inverter on.

E. Maintenance bypass/ Test mode:
A manual bypass switch shall be used to isolate the charger/rectifier inverter output and the static bypass for maintenance purposes. Isolation shall be achieved without load interruption.

F. Eco Mode:
Under normal conditions, the load shall be supplied by Mains 2 via the static bypass. If the main goes out of tolerance, the load shall be automatically transferred to the inverter.

1.6 ELECTRICAL CHARACTERISTICS
A. Power rating: Refer to relevant drawings and Schematics.
B. Active power: Refer to relevant drawings and Schematics.
C. Normal AC input: 415V ±10% (adjustable ±15%)
D. Frequency : 50 Hz ±10%
E. Current Distortion : THDI <4% with THM active filter. LC passive filters are not acceptable
F. Power factor : up to 0.95 with THM active filter
G. Bypass AC input : 415V ±10% three phase + neutral
H. Frequency : 50 Hz ±1%
I. UPS Output : 415V ±1% three phase + neutral
J. Frequency : 50 Hz ±0.05Hz
K. Voltage distortion : <1.5% ph/ph, <2% ph/N for linear loads <2% ph/ph, <3% ph/N for non-linear loads
L. Transient Response : +/- 2% for 0 to 100% & 100 to 0% load steps
M. Permissible overload : 150% for one minute and 125% for ten minutes
N. Parallel Operation: For redundancy or power up gradation facility should be available to parallel 4 units with a common bypass switch/breaker.
O. Battery backup : 15 minutes

P. Battery type : Sealed lead acid maintenance free, 10 year life

Q. Efficiency

R. Double conversion mode : up to 93.5%

S. Eco Mode : up to 97%

T. Noise level : 65dBA

U. Storage temperature :
   1. UPSs with batteries : -25°C +45°C dry heat
   2. Operating temperature : 0°C to +35°C
   3. Humidity: 95% without condensation at ambient temperature.

1.7 DEGREE OF PROTECTION

The degree of protection of UPS cubicles shall be IP20 or higher.

1.8 OTHER FEATURES

A. Cold start: This function shall make it possible to start the UPS even when Mains 1 is absent. The power shall be supplied by the battery for a period determined by the battery charge level and the power required by the load. However, the battery discharge time can never exceed three times the rated back up time plus two hours.

B. Media contacts board : This board shall provide 12 isolated relay contacts (250V, 1A) that may be used to activate indicating lights or buzzers to inform the user of the operation status of the UPS and the battery.

C. Event Log : This display PC board shall store up to 400 events (alarms, UPS status information, etc.) It shall also provide statistical information on a number of UPS parameters (battery backup time, number of transfers to battery power, number of transfers to the static bypass, current limiting, operating time on the inverter and on Mains 2).

D. This information may be accessed locally on the standard display or on a remote terminal via the JBUS protocol.

E. Solution Pac Software : Shall be installed on computer-network management platforms & shall be used to manage electrical power for an entire company:
   1. UPS programming
   2. display of mains voltage and frequency
   3. display of the battery status, charge level and remaining back up time
   4. logging of events occurring on the mains supply, etc

F. In the event of incidents on the mains supply, it shall be possible to program the system to send warning messages to a pager or a PC via electronic mail.
PART 2 - PRODUCT

2.1 RECTIFIER/CHARGER
A solid state rectifier, fully microprocessor controlled, shall convert the AC power from the mains into regulated DC power. A temperature sensor shall be used to control temperature compensation. The power shall be filtered to supply the inverter and charge the battery. The rectifier/charger shall be sized to support the inverter at full rated load and simultaneously charge the battery to 95% of its full capacity over a period equal to ten times the battery backup duration. The rectifier/charger shall be of modular construction to facilitate maintenance.

2.2 INPUT ANTI HARMONIC ACTIVE THM FILTER & PROTECTION
A. The input of the rectifier/charger shall be protected by fuses.
B. Input current shall be limited to 125% for the nominal input current.
C. Stand alone active filter of appropriate rating to be installed in shut configuration in the input of the UPS to reduce the input current harmonics to less than 4% at full load and improve the input power factor to 0.95. The active filter will employ latest state of the art DSP processors and a LCD display for operator interface. Offered Active Filters should comply to the Specifications attached for Active Filters.

2.3 BATTERY BANK
The battery shall provide backup energy for the UPS. Selection of the battery shall depend on:
A. The average duration of failures on the electrical mains supply;
B. The available means of long-term back-up, if any (diesel gen set etc.)
C. The type of application

2.4 INVERTER
A. Operation:
The inverter shall be made of three inverter legs with IGBT transistors and pulse width modulation (PWM). The built-in output transformer shall be of the delta/zig/zag type.
B. Output voltage and frequency 415V, 50 Hz
C. Thermal overloads
   The inverter overload capability shall depend on the current drawn, in order protect various components from excessive temperature rise.
   1. 2 hours from 1.05 In to 1.1In
   2. 30 mins from 1.1 to 1.15 In
   3. 10 mins from 1.15 In to 1.25 In (For p. f. =0.8)
   4. 3 mins from 1.25 In to 1.35 In
   5. 1 min from 1.35In to 1.65 In
D. Steady state regulation
1. ± 1% voltage for the RMS values of the phase to neutral and phase to phase voltages.
2. Synchronization range
3. From 0.25 - 2 Hz in 0.25 Hz steps. May be personalised.
E. Transient conditions
1. Operation with battery power : ±2% for 100% load steps
2. Operation without battery power +2%/-4% for 100% load
3. Return to the ±1% voltage range in less than 20 ms.
F. Non-linear loads
1. All phase conductors shall be sized for the rated current.
2. The neutral conductor shall be sized for 1.5 times the rated current.
3. Load Crest factor up to 3
4. Output voltage (ph-ph) distortion=2% maximum
5. Output voltage (ph-N) distortion=3% maximum
6. Mains 2 (AC input to bypass)
7. Mains 2 tolerances/transfer conditions:
   The inverter shall transfer the load to the mains 2 supply without interruption provided the following conditions prevail :
   a. voltage within the Un-10% to Un +10%
   b. frequency within the personalized tolerance range
   c. phase shift between inverter and Mains 2 voltages less than 3 degrees
8. Overload capability of the static switch:
   a)Thermal overloads : 1.25 In : for 10 mins > 1.35 In for 1 min

2.5 MAINTENANCE BYPASS
A. On-line single UPS units, parallel redundant UPSs or UPSs in Eco mode shall be equipped with a maintenance bypass which may be used to transfer the load directly to Mains 2. This is carried out using three switches. Step by step help shall be provided on the front panel of the UPS when the doors are open. Prior to transferring the load to the maintenance bypass the inverter must be shut down.
B. In parallel UPS configurations for capacity, the isolation switches shall be located in the external bypass panel.

2.6 STATIC BYPASS
A. The static bypass shall be sized for continuous operation under the following conditions :
   1. Transfer without interruption of power to the load
   2. The static bypass must enable automatic transfer to the Mains 2 supply without interruption of power to the load, following detection by the control electronics of one of the following conditions:
a) load on inverter greater than the rated output
b) battery discharged to the end of its back up time, Mains 2 within tolerances.
c) Inverter malfunction.

B. Manual transfer:
   a) It is possible to carry out a manual transfer from the UPS control panel.

2. Overloads:
   a) The static switch has the following overload characteristics:
      - >135% of rated inverter output can be sustained for 1 minute
      - 125% of rated inverter output can be sustained for 10 mins.

C. Microprocessor based control functions:
   The UPS controls circuits shall be microprocessor based. All operations and parameters shall be managed by internal software thus eliminating the need for manual settings and potentiometers. Self-test and diagnostics circuits shall be used to detect and isolate a fault, right down to the PC-board itself or the connections. All individual circuits on the PC-board and all connections can be checked.

2.7 CONTROL AND INDICATION PANEL
   The UPS shall be equipped with a control panel comprising system-status indications that may be used to control, monitor and display various system functions and parameters. The graphic display may be set to display data in English, French, etc.

2.8 MONITORING SYSTEM PARAMETERS
   A. Parameters displayed (RMS)
   B. input voltage (phase-to-phase);
   C. input current per phase;
   D. bypass input voltage (phase to phase & phase to neutral);
   E. bypass input frequency;
   F. inverter output voltage (phase to phase & phase to neutral);
   G. inverter output current per phase;
   H. input, output current & bypass frequency;
   I. percentage load at the inverter output;
   J. inverter output power factor
   K. inverter output in kVA and kW;
   L. DC voltage
   M. load crest factor.
   N. battery current (charge/discharge);
   O. battery backup time and remaining service life;
P. temperature in the battery cubicle

2.9 MIMIC PANEL

Five LEDs shall indicate the status of the following elements:

A. rectifier/charger
B. battery;
C. static switch
D. inverter
E. load

2.10 BUZZER RESET BUTTON

This button shall be used to stop the buzzer. However, a new malfunction will activate the buzzer again.

2.11 FULL SHUTDOWN/EMERGENCY POWER OFF

A. Full shutdown or emergency power off button shall be provided to activate the following:
   1. Shutdown of the inverter
   2. Opening of the static switch on the bypass
   3. Opening of the battery circuit breaker;
   4. Opening of an isolated relay contact on the Media contacts board
B. It shall be possible to activate the "full shutdown" function externally via a relay contact.

2.12 SPARE PARTS

A. The Contractor shall furnish lists of recommended spare parts by the manufacturer for 3 years (over and above the one year defect liability period) duly priced with his Tender.
B. The Employer/Engineer reserves the right to accept or reject the same either in full or in part and the contractor shall supply the spare parts as per the final approved list, at the time of handing over/taking over of the Project.
C. Spare parts shall be packed in suitable containers or boxes bearing labels, clearly designating the contents and the particular of equipment for which they are intended.
D. The Contractor shall properly store and protect the spare parts until the completion of the works and deliver the same to the Employer’s stores.

2.13 UPS SYSTEM SCHEDULES (TO BE FILLED BY THE TENDERER)

A. Schedule No. 1 UPS System Reference:

<table>
<thead>
<tr>
<th>Normal Operation</th>
<th>Standby Operation</th>
<th>Remarks</th>
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<tbody>
<tr>
<td>Supply Authority</td>
<td>ADWEA</td>
<td>Battery</td>
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<tr>
<td>Number of phases</td>
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<td>Phase sequence</td>
<td>RYB</td>
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<tr>
<td>Specification</td>
<td>Value 1</td>
<td>Value 2</td>
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<td>---------</td>
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<tr>
<td>Line voltage</td>
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<td>Phase voltage</td>
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<td>Frequency tolerances</td>
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<td>Total Harmonic Distortion (THD) in voltage +</td>
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<td>±45%</td>
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<td>Supply neutral arrangement</td>
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<td>3 Phase symmetrical short circuit level at UPS input</td>
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<td>-------- KA</td>
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</table>

**B. Schedule No. 2 (Electrical Requirements)**

1. **Load Description**
   - No. of phases
   - KVA rating
   - Power factor
   - Crest factor
   - Max. load step/surge current
   - duration
   - Operation
   
   3 KVA
   Not less than 0.9
   ----- :1
   ----- Amps for ----- sec.
   Parallel operation

2. **Nominal voltage**
   ----- V, ----- phase

3. **Voltage phase balance at stated Load**
   ----- % in accordance with IEC part 4.

4. **Nominal frequency**
   50 Hz.

5. **Load current THD levels**
   4.5%

6. **Battery autonomy period**
   30 minutes

7. **Type of batteries**
   Sealed Lead Acid, long life (10 min.)

8. **Output Voltage**
   ----- V, ----- phase

9. **Output Frequency**
   50 Hz ± 0.5%

10. **Operating temperature**
    -5o C to 35o C

11. **Noise Level**
    Less than or equal to 65 dBA (ISO 3746)

**C. Schedule No. 3**

   **Instrumentation for each UPS System**

   1. Input supply

   i. AC voltmeter with 7 position
      selector switch (Ph-Ph, Ph-neutral :
      selector and off selection)

   ii. AC ammeter - 3 Nos.(one for each phase) :
iii. Frequency meter :
iv. Kilowatt meter (indicating total power) :
v. Battery voltmeter :
vi. Battery ammeter (for charge/discharge indication) :

2. Output Supply
i. AC voltmeter with 7 position selector switch (Ph-Ph, Ph-neutral : selector and off selection)
ii. AC ammeter - 3 Nos.(one for each phase) :
iii. Frequency meter :
iv. Kilowatt meter (indicating total power)
3.1 TRANSFER TESTS

A. With a nominated test load connected to the UPS output stage, monitor the output voltage and frequency, utilising transient recording instrument, while carrying out the following sequence of tests. The necessary load basics for conducting following tests shall be arranged by the Sub Contractor.

B. Automatic transfer of the load to and from the bypass circuit, should be via, isolation transformer.

C. Manually transfer the load to and from the bypass circuit.

D. For multi-module system, bring each module line. Check each module shows the load.

E. With an appropriate load connected, remove the modules off-line one at a time until system 'overload' is indicated and the load transfers to bypass.

F. With an appropriate load connected to the UPS output stage, verify that the load transfers to bypass when a system under voltage is simulated.

G. Simulate a 'transfer to UPS' failure and verify that the appropriate indicator lamp is illuminated.

3.2 COMMISSIONING

A. Verify correct voltages and phase rotation at the supply point.

B. Verify correct voltages and phase rotation at input of rectifier/charger.

C. Verify correct link voltage and waveform after the smoothing stage.

D. Verify DC link walk-in with the inverter stage switched on.

E. Check AC waveforms and inverter output voltages after smoothing stage.

F. Verify that the internal noise and vibration levels specified in Clause 1.7 of Section 210548 are achieved.

3.3 WARRANTY

A. The Contractor / supplier shall warrant that:

B. The supplied equipment shall be free from defects and shall perform as to comply with these specifications and shall undertake to repair and/or replace at his own cost and expense, such items and equipment supplied by him, which are not in accordance with specifications or otherwise defective, within 15 days after a written notice from company is issued.

C. This warranty shall be valid for twelve (12) calendar months from the date of successful commissioning of the supplied equipment.

3.4 TESTING

A. After completion of UPS system installation by the sub contractor, a comprehensive site testing shall be done to confirm/check the following, prior to operation. All tests shall be witnessed by Engineer/Employer’s representative.

B. All system components are delivered to site undamaged.
C. The system is complete with all components as specified and described in the schedules.
D. Installation of system is carried out in compliance with the specifications and the drawings.
E. The system performs in accordance with the specifications both in normal and standby power supply conditions.
F. Check tightness of all internal power connections including batteries.
G. Check correct operation and sealing of doors and covers.
H. Check all clearances between live parts and enclosure metal works.
I. Check the proper operation and ambient conditions of the Local air conditioning system.

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1.1 GENERAL INSTRUCTIONS
Works under this section shall be governed by Conditions of Contract.

1.2 SCOPE
A. The Contractor shall, unless otherwise indicated on the Drawings or Bills of Quantities, supply, install and connect the lighting fixtures including but not limited to lamps, ballasts, accessories, fixing hardware necessary for installations, as shown on the Drawings, as required, and as herein specified.
B. Fixtures shall comply with all applicable requirements as herein outlined unless otherwise specified or shown on the Drawings.
C. The Contractor shall be responsible to supply the specified lighting fixtures as indicated on the drawings. Technically equivalent and architecturally acceptable lighting fixtures may be accepted with proper price justification and to the decision of Engineer.

1.3 CODES AND STANDARDS
A. Fixtures shall be completely wired and constructed to comply with IEC Publication 598-1598-2 and BSEN 60598-1: 1993 unless otherwise specified.
B. All luminaries supplied by the contractor shall be photo metrically tested to BS 5225: Part 1.
G. Specification Capacitors - BSEN 61048:1993
I. Earth leakage current must be below 0.4 mA measured according to IEC-598-1.
J. Radio frequency interference must be in accordance with EN 55015.
K. Ballast must be in accordance with IEC 928 (ballast safety) and IEC 929 (ballast performance).
L. Total harmonic distortion must be below 10% and in accordance with EN 6000-3-2.

1.4 APPROVED MANUFACTURERS
Approved manufacturer for lighting accessories shall be any one of the following manufacturers or approved equal
A. Lighting fixtures – refer to lighting fixtures schedule
B. Lamps
   1. Philips (Holand)
   2. Osram (Germany)
   3. GE (USA)
C. Ballasts
   1. Tridonic
   2. Luxmate
   3. Ectron

1.5 FIXTURE SAMPLES

Detailed catalogue cuts for all fixtures and samples of fixtures shall be submitted for review and acceptance of the Engineer before placing order for the lighting fixtures.
PART 2 - PRODUCT

2.1 MATERIALS

A. Fixture, housing, frame or canopy, shall provide a suitable cover for fixture outlet box or fixture opening.

B. Fixtures shall not cause a temperature exceeding 90 degree centigrade on any outside surface.

C. Fixtures shall bear manufacturer's name and the factory inspection label.

D. Relamping the fixture shall be possible without having to remove the fixture from its place.

E. Certain fixtures may be shown in provisional position. They shall be exactly located as soon as the final layout of equipment is known.

F. Any plastics used in the luminaries shall be light and U.V. stable and shall be suitable for their application.

G. All sheet steel components shall be suitably pre-treated and electro statically spray-painted using acrylic polyester or epoxy powder paint.

H. Fixtures that are used under canopy or directly exposed to weather shall be considered as being outdoor type.

I. Indoor fixtures shall be constructed of 0.7 mm thick steel minimum. If other metals are used they shall be of the required thickness to have at least the same mechanical strength.

J. Cast portions of fixtures shall be not less than 1.5 mm thick.

K. Metal parts of the fixtures shall be completely free from burrs and tool marks. Solder shall not be used as a mechanical fastening device on any part of the fixture.

L. Fixtures with visible frame shall have concealed hinges and catches.

M. Recessed fixture shall be constructed so as to fit into ceiling without distorting either the fixture or the ceiling. Plaster rings shall be provided for plaster ceilings. The Contractor shall coordinate the dimensions with the false ceiling tile or panel dimensions.

N. Outdoor fixtures (under canopy or directly exposed to the weather) shall be constructed of an appropriate weather resistant material including gaskets to prevent entrance of water into wiring.

O. External fixtures shall be constructed to minimum classification of IP55 and be class II unless otherwise stated.

P. Fixtures with hinged diffuser doors shall be provided with spring clips or other retaining devices to prevent the diffuser from moving.

Q. Bathroom fixtures shall be marked as being suitable for damp locations and shall be of minimum IP44 degree of protection, class-1. Lamp holders of such fixtures shall be provided with a protective shield to prevent contact with the lamp cap.

R. Fixtures with exposed metal parts shall be provided with a means for connecting an equipment earthing conductor for such fixtures.
S. Incandescent fixtures shall be equipped with porcelain medium base with nickel-plated shells. Sockets shall be bayonet type for lamps up to and including 150 watts and right hand screw type for lamps 200 watts and above.

T. Lighting fixtures intended for use as emergency lighting either as self contained or slave type shall be "F" marked when used in or on ceilings consisting of flammable material.

U. Pendent fixtures and lampholders shall be provided with ball type aligners.

V. Heat generated by any lighting fixture shall not affect any part of the fitting.

W. Diffuser and the body of the lighting fixtures shall be guaranteed for stable color for 5 years under the site condition.

2.2 FLUORESCENT FIXTURES

A. Fixtures shall be provided with white click-in type lamp holders.

B. Pendent individually mounted fixtures 60 cm and longer shall be provided with twin stem hangers. Stems shall have ball aligners and provision for a minimum of 2.5 cm vertical adjustment.

C. Diffusers shall be manufactured from one piece non-glued methacrylate.

D. Mirror system light controlled fixtures shall comprise a metal encased aluminum mirror system with aluminum mirror strips forming a parabolic reflector. Lamps shall be screened in the longitudinal direction by means of matt-white louver partitions unless otherwise specified on the drawings.

E. Clear smooth diffusers shall be smooth from outside, finely grained from inside.

F. Corrosion resistant fixtures shall comprise polyester resin fiber-glass reinforced body, dust and splash-proof.

G. Damp-resistant fixtures shall comprise polyester resin fiberglass reinforced body, dust and jet-proof.

H. Luminaries containing compact fluorescent lamps shall be designed to ensure the correct working conditions for the lamp.

I. All compact fluorescent luminaries shall, unless otherwise stated, be supplied with low loss control gear and single pulse electronic starters.

J. Explosion proof fixtures if any shall be suitable for hazardous location specially for paint spray booths, and locations having deposits of readily combustible paint residue. All exposed hardware shall be stainless steel. All exterior material shall be non-sparking.

2.3 FINISH

A. All hardware shall be bonderized, cadmium-plated, given a corrosion-resistant phosphate treatment or other acceptable rust inhibiting prime coat, to provide a rustproof base before application of finish.

B. Finish shall be baked enamel.

C. Non-reflecting surfaces such as fixture frames and trims shall be finished with baked enamel paint, unless otherwise specified. The color of the paint shall be as indicated on the Drawings or as directed later by the Engineer on Site.
D. Light reflecting surfaces shall be finished with baked white enamel paint having a reflection factor of not less than 85%.

E. All parts of the reflector shall be completely covered by the finish and free from irregularities.

F. Unpainted surfaces shall be finished with a clear lacquer except for anodized or "Azac" surfaces.

G. After finish has been applied and cured, it shall be capable of withstanding a 1 cm radius bend without showing signs of cracking, peeling or loosening from the base metal.

H. Finish shall be capable of withstanding 72 hours exposure to an ultra-violet RS sun lamp placed 10 cm from the surface without discoloration, hardening, or warping and shall retain the same reflection characteristics after exposure.

2.4 LAMPS – GENERAL

A. Lamps shall be supplied and installed in all lighting fixtures listed in the Schedule of Lighting Fixtures on the Drawings.

B. Lamps used for temporary lighting services shall not be used in the final lamping of fixture units.

C. Lamps shall be of wattage and type as shown in the Schedule of Lighting Fixtures.

D. Lamps for permanent installation shall not be placed in the fixtures, until so directed by the Engineer, and this shall be accomplished directly before the building areas are ready for occupancy by the Employer.

2.5 LAMPS – FLUORESCENT

A. Lamps shall be of the normal start energy saving type, unless otherwise indicated.

B. Tubular fluorescent lamps shall be 26 mm dia. and shall have tri-phosphor coating.

C. Lamps shall have bi-pin bases and a minimum approximate rated life of 8,000 hours.

D. Lamps with WHITE color rendering shall have the color rendering features similar to ‘TL'D color 84 at 4000K and lamps with WHITE DELUXE color rendering shall have the color rendering features of ‘TL'D color 83 at 3000 K. Lamps shall have 96 lm/ watt output minimum based on 36 watt lamps.

E. Compact fluorescent lamps shall be of the 4-pin type manufactured in accordance with BS 6982.

F. Compact fluorescent lamps shall be suitable for operating as emergency lighting sources where specified.

G. Compact fluorescent lamps shall be suitable for operating on standard wire wound and H.F. ballasts.

H. Where the lamps are used horizontally, they shall be adequately supported along their length.

I. Lamps shall have WHITE color rendering unless otherwise indicated.

2.6 LAMPS - INCANDESCENT

A. Incandescent lamps shall be inside frosted type, unless otherwise indicated.
B. Lamps shall have a minimum approximate rated life of 750 hours. Lamps shall have medium base bayonet type for lamps up to 150 watts and right hand screw type for lamps 200 watts and above unless otherwise indicated or permitted.

C. Approved manufacturers, products and suppliers

D. Lamps shall be manufactured by Philips (Holland) or approved equal.

2.7 LAMPS - HALOGEN

A. Halogen lamps shall be either mains-voltage or low voltage type as described in the lighting fixtures schedules in the drawings.

B. The tubular envelope of the lamp which is made of a special quartz glass shall be resistant to the high temperatures needed for the halogen cycle to function.

C. Care shall be taken in handling the quartz envelope lamps, where the lamp should not be handled directly.

D. The lamp shall be cleaned using soft cloth moistened with white spirits.

E. Luminaries using low voltage tungsten-halogen lamps shall be supplied complete with its own transformers unless otherwise stated. Wire wound transformers shall be rated at 250/11.8 volts and shall comply with IEC742, class I/class II and be insulated to class H of BS 2757.

F. Transformers shall be protected against overload and short circuiting.

G. Final connections to luminaries shall be carried out using silicon rubber sheathed cables.

H. Dimmers for low voltage tungsten-halogen lamps shall be hard wired type suitable for inductive loads.

I. Transformers used in dimmed circuits shall be down rated as recommended by the manufacturer.

J. Electronic transformers shall be protected against short circuit and overload. It shall contain a soft start circuit and be self regulating.

K. Electronic transformers shall comply with IEC 742 and 34C/comex (PK) 8 and 14 with RFI suppression complying with BSEN 55014:1993.

L. Electronic transformers used in dimmed circuits shall be suitable for dimming. The dimmer shall be compatible with the transformer. When installed in ceiling voids, the transformer shall be capable of subsequent removal either through the fitting aperture or through an access panel.

M. Lamp holders in dichroic or capsule luminaries shall be easily accessible for relamping.

N. Where sealed low voltage lamps are used the luminaire shall be designed to cope with the increased temperature.

O. The integral wiring of dichroic lamps shall cope with the increased temperature.

P. All dichroic lamps shall be of the captive type.

Q. Capsule low voltage lamps shall not be installed using bare hands. Protective glass shall be incorporated in capsule lamps fittings.
R. Mains voltage tungsten halogen lamps shall be either of the single ended or double ended type as specified in the fixtures schedule. The single-ended lamps shall be of the frosted version unless otherwise specified or directed by the Engineer.

S. Double envelope and reflector lamps could also be implemented if specified or directed on site.

T. The design of main voltage luminaires shall insure the withstanding of bulb wall temperature of 250 degree C and a maximum pinch point temperature of 350 degree C.

2.8 COLD CATHODE LAMPS

A. Cold cathode tubes shall be of the length and color specified in the lighting fixtures schedule in the drawings.

B. The cold cathode circuits shall be of the high voltage/low voltage high frequency type.

C. High voltage sub-circuits shall be wired in lead sheathed cable or silicone rubber insulated cable rated up to 15KV.

D. All high voltage installations shall have an isolating fireman's switch. The location of the switch shall be as required and directed by Local Civil Defence Authorities.

E. All installations shall be power factor corrected to a minimum power factor of 0.9 lagging or as otherwise stated.

F. Cold cathode lamps shall have turned back/drop seal electrodes. Lamps used externally shall be sheathed over the electrodes with silicon seals, to prevent ingress of moisture, unless enclosed in an appropriately rated luminary.

G. Low voltage cold cathode lamps shall operate at a voltage less than 1000 volts.

H. Lamps to be installed end to end shall use right angle turn back electrodes.

I. Remote mounted ballasts shall, where possible be grouped together with bulk power factor correction to give a power factor of min. 0.9 lagging. The ballast shall be capable to be mounted up to 100 mm away from the lamps.

J. Safety extra low voltage high frequency cold cathode lighting shall consist of a step down transformer 240/24V, a high frequency electronic ballast and a 20 mm diameter lamp.

K. Remote transformers shall be separately supported and be readily accessible.

L. Transformers not containing primary fuse protection shall be provided with accessible local protection.

2.9 LAMPS - MERCURY VAPOR, AND METAL HALIDE

A. Mercury lamps shall be high-pressure mercury-vapour fluorescent lamps, with a quartz discharge tube enclosed in an internally coated ovoid outer bulb.

B. The quartz discharge tube shall contain a small quantity of mercury and a starting gas.

C. The average luminous flux after 100 burning house shall for a 50 W lamp, be 1850 lumens horizontal and 2000 lumens vertical. The number of minutes after which the lamp has reached 80% of its final luminous flux shall not exceed 5 minutes for 50 W lamps, and 4 minutes for higher wattage lamps.

D. Lamps below 125 W shall be fitted with normal glass and lamps 125 W and above shall be fitted with hard glass.
E. Metal Halide lamps shall be similar to mercury vapor lamps except that the discharge tube shall contain metal halide compounds and the average luminous output after 100 burning hours for a 375W lamp shall not be less than 30000lm

F. Approved manufacturers, suppliers and products.

G. Lamps shall be similar to Philips HPL-N type or approved equal.

### 2.10 LAMPS - HIGH PRESSURE SODIUM

A. High pressure sodium vapor lamp shall be suitable for outdoor use. It shall include a sintered aluminum oxide discharge tube enclosed in a clear, tubular hard-glass outer bulb.

B. The average luminous flux after 100 burning hours shall be the following:

C. For 150 watts: 14000 lumens.

D. For 250 watts: 27000 lumens.

E. For 400 watts: 47000 lumens.

F. For 1000 watts: 125000 lumens.

G. The number of minutes after which the lamp reaches 90% of its final luminous flux shall be the following: For 150, 250 and 400 watts, 5 minutes.

H. For 1000 watts, 6 minutes.

I. The re-ignition time shall not exceed 3 minutes.

J. The lamp shall be suitable for universal burning position.

K. The lamp shall be able to operate in both high (+50 deg C) and low (-50 deg C) ambient temperatures.

L. The lamp shall have a stable operation with supply voltage as low as 200 Volts.

### 2.11 BALLASTS - FLUORESCENT

A. Only single and/or two-lamp ballast shall be used in any one fixture.

B. Ballasts shall be of low loss and high power factor type, with a minimum power factor of 0.9. Voltage rating shall be equal to the nominal voltage or be the next higher standard.

C. Ballasts sound performance shall be suitable for the lowest sound level likely to be encountered in the subjected space with sound ratings as shown on the Lighting Fixtures Schedules of the Drawings.

D. Ballasts shall have manufacturer's lowest sound level and case temperature rise rating.

E. Ballasts shall be special cool operated type.

F. Ballasts shall be rapid start type unless otherwise indicated.

### 2.12 STARTERS - FLUORESCENT

A. Starters shall produce a sufficiently high peak voltage for proper ignition of the lamp. Ample re-heating of the lamp electrodes prior to ignition shall be provided to have a favorable effect on the life of the lamp with a minimum of end blackening.

B. The glow-switch and a radio-interference suppression capacitor shall be safely housed in a high quality white polycarbonate canister ensuring excellent insulation.
C. Starters shall comply with IEC 155/155A or approved equal.

2.13 STARTERS - FLUORESCENT (ELECTRONIC)
A. Starters shall be electronic type, enclosed in a polycarbonate box mounted inside the luminaire with the ballast.
B. Electronic starters shall comply with BS 3772 Part 1.
C. Starter shall provide immediate ignition (0.5 seconds) of standard fluorescent lamps to comply with BS 3772.
D. Starters shall have negligible watt loss, and shall be noiseless.
E. Approved manufacturers, products and supplier.
F. The starters shall be similar to the universal vivatronic catalog ref. G69577 as manufactured by Thorn EMI Lighting, ES 08 as manufactured by Philips or approved equal.

2.14 BALLASTS - FLUORESCENT (ELECTRONIC)
Ballast shall be solid state electronic controlled type with no noise nuisance, high operating frequency, 0.95 power factor, instant non-flickering start, automatic switch-off if lamp is defective, no stroboscopic effect and no electrode flickering. All components shall be mounted on a common wiring board, with a sheet metal housing for mechanical protection. It shall require no starter.

2.15 BALLASTS - FLUORESCENT (ELECTRONIC CONTROLLABLE)
A. Electronic controllable fluorescent ballasts shall be dimmable with a dimming range from 5 to 100%.
B. The ballast shall be noiseless with no buzzing at any light level.
C. The power factor must not fall below 0.8 at any lighting level and shall be more that 0.95 at full lighting level. The total harmonic distortion must not exceed 10% in accordance with EN 61000-3-2 through the entire dimming range.
D. The radio frequency interference must be in accordance with EN 55015 through the entire dimming range.
E. The unit shall be similar to electronic control gear as manufactured by Philips, Siemens or approved equal.

2.16 CAPACITORS
A. Power factor correction capacitors shall be metal foil dry type impregnated paper, metallized film or polypropylene film, encased in an insulated aluminum canister. Capacitors shall be rated at 250V, 50/60 Hz and BS EN 61049:1993. They shall be rated 800 volt, 50/60Hz.
B. Radio interference suppression capacitors shall be dry type ceramic or equivalent complying with BS EN 61048:1993 7. They shall be rated at 800 volts, 50/60 Hz.

2.17 BALLASTS - MERCURY VAPOR
A. Ballasts shall be suitable for use in the area to be installed.
B. Ballasts for 400 W lamp shall consist of two parts = gear housing and cover.
C. The housing and the cover are made of polyamide, which is heat, impact and stress resistant, with very good insulating properties.

D. The ballast box shall be protected to IP 54.

E. All ballast boxes shall include the integral ballast, the igniter, the capacitors for power factor correction to min 0.85, a terminal block, and two properly rated fuses.

2.18 BALLAST AND IGNITION DEVICE - SODIUM

A. All Sodium lamps shall be equipped with individual control gears comprising a ballast and an ignition device.

B. The igniter housing shall be able to withstand a +850°C temperature. All control gears shall be equipped with capacitors so as to raise the power factor to 0.85. Ballasts shall have low losses which shall not exceed the following values:

1. For 150 watts lamps, 20 watts losses.
2. For 250 watts lamps, 30 watts losses.
3. For 400 watts lamps, 36 watts losses.
4. For 1000 watts lamps, 60 watts losses.
5. Ballasts shall operate with a voltage range of 210 to 240 V, with 50 Hz frequency.

2.19 WIRING

Wiring within fixture and for connection to the branch circuit wiring up to the outlet box of lighting point shall not be less than 1.5 mm². Insulation shall be silicone rubber, finish shall be glass braid. Suitable for 150 degree centigrade normal service temperature, 300/300 volts. Cable entry to fixture shall be dust sealed.
PART 3 - EXECUTION

3.1 INSTALLATION

A. Fixtures shall be installed at mounting heights as detailed on the Drawings or as instructed on Site by the Engineer.

B. Fixtures and/or fixture outlet boxes shall be provided with hangers to adequately support the complete weight of the fixture. Design of hangers and method of fastening, other than shown on the Drawings or, herein specified, shall be submitted to the Engineer for review and acceptance.

C. Pendent fixtures within the same room or area, shall be installed plumb and at a uniform height from the finished floor. Adjustment of height shall be made during installation.

D. Flush mounted recessed fixtures, shall be installed so as to completely eliminate leakage of light within fixture and between the fixture and adjacent finished surface.

E. Fixtures mounted on outlet boxes shall be rigidly secured to outlet box. Hickeys or extension pieces shall be installed where required to facilitate proper installation.

F. Surface mounted fixtures longer than 60 cm shall have one additional point of support besides the outlet box fixture stud when installed individually.

G. Fixtures located on the exterior of the building shall be installed with non-ferrous metal screws finished to match the fixtures.

H. Where edison screw lamp holders are used, the outer contact must be connected to the neutral conductor.

I. Fixtures installed in false ceiling shall be connected to the relevant lighting outlet through a flexible cord & ceiling rose, unless otherwise specified under "CONDUITS". Each fixture shall have its corresponding lighting outlet.

End of Section 26 51 13
IT SPECIFICATION
## IT Works Specifications

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PART 1 – GENERAL

1.1 RELATED DOCUMENTS
A. Drawings and general provisions Contract, including General and Supplementary Conditions and Division 01 Specifications Sections, apply to this section.

1.2 SUMMARY
A. This section includes:
   1. Access flooring panels and understructure
   2. Floor panel coverings
   3. Various accessories, including, but not limited to ramps, steps and electrical boxes.
B. Related Sections include the following:
   1. Division 3 Section ‘Cast-In-Place Concrete’ for concrete floor sealer.
   2. Division 26 Section ‘Grounding and Bonding for Electrical Systems’ for connection to ground of access flooring understructure.
      Note: The electrical contractor shall provide the necessary labor and materials to electrically connect the access flooring to the building ground to comply with this section.
C. Quantity Allowances: Provide the following as specified in Division 01 Section ‘Allowances.’
   1. Cutouts in floor panels
   2. Service outlets

1.3 DEFINITION
A. Access flooring: A complete portable assembly of modular floor panels on an elevated support system (understructure), forming an accessible under-floor cavity to accommodate electrical and mechanical service.
B. ESD: Electrostatic Discharge. The transfer of electric charge between bodies at different potentials.

1.4 SYSTEM DESCRIPTION
A. Access Flooring System: Assemblies composed of modular floor panels on stringers that are bolted to adjustable height pedestals.

1.5 PERFORMANCE REQUIREMENTS
A. Structural Performance: Provide access flooring system capable of supporting the following loads and stresses within limits and under conditions indicated, as demonstrated by testing manufacturer’s current standard products according to referenced procedures in latest revised edition of Ceilings and Interior Systems Construction Associates (CISCA) ‘Recommended Test Procedures for Access Floors’ referenced elsewhere in this section as CISCA/AF or, if not specified, manufacturers standard method
   1. Concentrated Loads: Provide floor panels, capable of withstanding a concentrated design load of 1,250 lbf. (4448 N) with a bottom-surface deflection under load not to exceed 0.080 inch (2.03) and a permanent set not to exceed an average of 0.010 inch (0.25) according to CISCA/AF Section 1, ‘Concentrated Loads’
   2. Ultimate Load: Provide access flooring system capable of withstanding a minimum ultimate load of three times the concentrated load without failing, according to CISCA/AF, Section 2, ‘Ultimate Loading’
   3. Rolling Loads: Provide access flooring system capable of withstandi
following magnitude, with a combination of local and overall deformation not to exceed 0.040 inch (1.02 mm) after exposure to rolling over CISCA/FA Path A or B, whichever path produced the greatest top surface deformation, according to CISCA/AF, Section 3, ‘Rolling Loads’.

a. CISCA/AF Wheel 1 Rolling Load: 500 lbf. (2224 N)
b. CISCA/AF Wheel 2 Rolling Load: 500 lbf. (2224 N)

4. Stringer Load Testing: Provide stringers, without panels in place, capable of withstanding a concentrated load of 550 lbf (2447 N) at center span with a permanent set not to exceed 0.010 inch (0.25 mm), as determined per CISCA/AF Section 4, Stringer Load Testing.

5. Pedestal Axial Load Test: Provide pedestal assemblies, without panels in place, capable of withstanding a 9,000 lbf (40,034 N) axial load per pedestal, according to CISCA/AF Section 5, ‘Pedestal Axial Load Test’ without any permanent deformation.

6. Pedestal Overturning Moment Test: Provide pedestal assemblies, without panels in place, capable of withstanding an overturning moment of 1,000 inch-pounds (113 NM) per pedestal, according to CISCA/AF Section 6, ‘Pedestal Overturning Moment Test’ when glued to a clean, sound, uncoated concrete surface.

7. Uniform Load Test: Provide access flooring system capable of withstanding a uniform load of 350 lbf/ft² (16,758 N/M²) placed over area one panel with a permanent set not to exceed 0.010 inch (0.25 mm) after the load is removed, according to CISCA/AF Section 7, ‘Uniform Load Test’.

Note: The uniform load rating of an access floor panel shall not be confused with the uniform live loads as specified for use in seismic calculations for seismic zone applications.

8. Drop Impact Load Test: Provide access flooring system capable of withstanding a drop impact load of 150 lb. (68 kg) dropped from a height of 36 inches (914 mm) without a failure of the system, according to CISCA/AF Section 8, ‘Drop Impact Load Test’.

9. Panel Drop Test: Provide access flooring system with panels capable of meeting all structural performance requirements specified, after the panel is dropped from a height of 36 inches onto a concrete surface.

B. Seismic Performance: Provide access flooring system capable of withstanding the effects of seismic motions as calculated for the area of installation according to used code.

C. ESD-Control Properties:

1. Provide access flooring system with Panel-to-Understructure resistance of not more than 10 ohms as measured without floor coverings, according to test method as specified in ASTM F 150 with 500-V applied voltage with one electrode on the top face of the panel and one electrode attached to the tube of the pedestal.

   a. Panel must have a permanently attached positive grounding device (PGD) to assure electrical continuity between panel and understructure to maintain compliance to required maximum resistance of 10 ohms.

2. Static-Resistant High Pressure Laminate (HPL) Floor Covering Properties:

   a. Electrical Resistance: Test per ASTM F 150 with 500-V applied voltage.

      1) Average no less than one megohm (1.0 x 10⁶) and not greater than 20,000 megohms (2.0 x 10¹⁰) when tested surface-to-ground.
1.6 SUBMITTALS
A. Product Data: For each type of product indicated.
   1. Shop Drawings: Include complete layout of access flooring system based on field verified dimensions.
      a. Details and sections with descriptive notes indicating materials, finishes, fasteners, typical and special edge conditions, accessories and understructure.
      b. Detail Cut Sheets for each type of product indicated, including accessories, to show the information necessary to make a full evaluation of the entire flooring system.
      c. For installed products indicated to comply with seismic design loads, include calculated structural analysis data signed by the qualified engineer responsible for their preparation.
   2. Samples for Initial Selection: For each type of flooring material indicated and exposed finish indicated, submit samples in the form of manufacturers color charts consisting of actual units or sections of units showing full range of colors, textures and patterns.
3. Samples for Verification: Full size units of each type of floor covering and exposed finish indicated.

B. Product Certificates: For each type of access flooring system indicated, to certify that the flooring system meets the requirements of these written specifications and signed by a qualified employee of the manufacturer.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, or performed by access flooring manufacturer and witnessed by a qualified testing agency, for each type of flooring material and exposed finish.

1.7 QUALITY ASSURANCE
A. Installer Qualifications: Engage an experienced installer who is approved by the access flooring manufacturer for installations of the type of access flooring indicated for this project.
B. Source Limitations: Obtain access flooring system through one source from a single manufacturer.
C. Regulatory Requirements: Fabricate and install access flooring system to comply with NFPA 75 requirements for raised flooring.
D. Provide floor panels that are clearly marked with manufacturer’s name and panel type.
E. Mockups (if required): Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
   1. Build mockup of typical access flooring assembly as shown on Drawing. Size to be an area no less than [three] <Insert number> floor panels in length by [three] <Insert number> floor panels in width.
   2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
G. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
   1. Review connection with mechanical and electrical systems.
   2. Review and finalize construction schedule and verify availability of materials, Installer’s personnel, equipment, and facilities needed to make progress and avoid delays.

1.8 DELIVERY, STORAGE AND HANDLING
A. Deliver access flooring components in original, unopened packages, clearly labeled with manufacturer’s name and item description.
B. Handle and store packages containing access flooring in a manner which avoids overloading building structure.

1.9 PROJECT CONDITIONS
A. Environmental Limitations: Do not install access flooring until installation area is enclosed and has an ambient temperature of between 50 degrees Fahrenheit and 85 degrees Fahrenheit (10°C to 29°C) and a relative humidity of not less than 20 percent and not more than 80 percent.

1.10 COORDINATION
A. Coordinate locations of mechanical and electrical work in under-floor cavity to prevent interferences with access flooring pedestals
B. Pre-mark pedestal locations on a grid of 100 mm x 100 mm under-floor so that mechanical and electrical work can take place without interfering with pedestals.
C. Do not proceed with installation of access flooring until after substantial completion of other performable construction within affected spaces.

1.11 EXTRA MATERIALS
A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage and identified with labels clearly describing contents.
   1. Standard field panels ï 2%
   2. Pedestals ï 2%
   3. Stringers ï 2%

PART 2 - PRODUCTS

2.1 FLOOR PANELS AND UNDERSTRUCTURE
A. Manufacturers: Subject to compliance with requirements, provide access flooring by ASM Modular Systems, Inc., consisting of S125 access floor panels supported on a bolted stringer understructure.

B. Floor Panels General: Provide modular panels complying with the following requirements, that are interchangeable with other standard field panels, and can be easily relocated by one person, using a lifting device, without disturbing adjacent panels or understructure. Installed panels with floor covering in place are to be free of exposed metal edges.
   1. Nominal Panel Size: 240x240(610 mm x 610 mm) <or 600 mm x 600 mm>
   2. Fabrication Tolerances: Fabricate panels to the following tolerances with squareness tolerances expressed as the difference between diagonal measurements from corner to corner.
      a. Size and Squareness: Plus or minus 0.010(0.12 mm) of required size, with squareness tolerance of plus or minus 0.015(0.38 mm).
      b. Flatness: Plus or minus 0.020(0.50 mm), measured on a diagonal on top of the panel.
   3. Panel Attachment to Understructure: By gravity.
C. Formed-Steel Panels: Fabricate panels with a die formed all-steel bottom pan consisting of a minimum 64 embossments, fully welded to a die-cut full-hard steel top sheet to form a structural
unitized construction. Panels to be cleaned with 3-part wash and rinse system, prior to applying a powder-coat epoxy finish.

1. Solid Panels: Flat, solid top surface
2. Raised Panels:
   b. Finish: Provide grate panels with manufacturer's standard finish.

D. Pedestals: Provide manufacturer's standard pedestal assembly including base, column with provisions for height adjustments, and head (Cap), made of steel.
   1. Base: Square base plate with not less than 16 square inches (103 sq. mm) of bearing area.
   2. Column: Welded to base plate and of height required to bring finished floor to elevations indicated.
   3. Provide vibration-proof leveling mechanism for making and holding fine adjustments in height over a range of not less than 2 inches (50 mm) and for locking at a selected height, so deliberate action is required to change height setting and prevents vibratory displacement.
   4. Construct pedestal adjusting rod of minimum 3/4" (19 mm) diameter solid steel, and vertical column of minimum 7/8" (22 mm) square steel tubing. All steel components to have manufacturer's standard galvanized finish.
   5. Head: Pedestal head to accept bolted stringers as specified below.

E. Stringer System: Manufacturer's modular steel stringer system designed and fabricated to interlock with pedestal head and to form a grid pattern with a stringer under each edge of each floor panel and a pedestal under each corner of each floor panel. Protect steel component against corrosion with manufacturer's standard galvanized finish.
   1. Bolted Stringers: System of main and cross stringers of sizes shown below, attached to pedestal heads with 1/4-20 fasteners accessible from top of stinger.
      a. (2x2 or 4x2 or 4x4 or 4x4basketweave) <Insert required system>
   2. Provide stringers that support each edge of each panel where required to meet design load criteria.

2.2 FLOOR PANEL COVERINGS
   A. General: Provide factory-applied floor coverings of type indicated that are laminated by access flooring manufacturer to tops of floor panels.
   B. Colors, As selected by Architect from manufacturer's full range.
   C. Provide floor covering materials in colors and patterns as indicated below:
1. Standard Plastic Laminate (HPL): NEMA LD 3, High wear type, \([1/16\)"] \([1/8\)”]; fabricated in one piece to cover each panel face with integrated trim serving as edging.

D. Edge Condition of HPL: Provide HPL with "Smart-Trim" integrated as an internal element of the HPL material with no machined grooves at the edge of the HPL to allow for the collection of dirt and debris.

2.3 ACCESSORIES
A. Service Cutouts: Fabricate cutouts in floor panels to accommodate cable penetrations and service outlets. Comply with requirements indicated for size, shape, number, and location. Provide reinforcement or additional support, if needed, to make panels with cutouts comply with standard performance requirements.

1. Fit cutouts with manufacturer’s standard grommets in size indicated or, where size of cutouts exceeds maximum grommet size available, trim edge of cutouts with manufacture’s standard plastic molding having tapered top flange. Furnish removable covers for grommets.

2. Provide foam-rubber pads for sealing annular space formed in cutouts by cables. Trim edge of cutout with molding having a double-flanged internal edge for containing and supporting foam pads.

B. Vertical Closures (Fascia): Where under floor cavity is not enclosed by abutting walls or other construction, provide manufacturer’s standard metal closure plates with manufacturer’s standard finish.

C. Ramps: Manufacturer’s standard ramp construction of width and slope indicated, but not steeper than 1 : 12, with non-slip raised-disc runner or vinyl floor covering, and of same materials, performance, and construction requirements as the access flooring.

D. Steps: Provide steps of size and arrangement indicated with floor covering to match access flooring. Apply non-slip aluminum nosing to treads, unless otherwise indicated.

E. Panel Lifting Device: Manufacture's standard portable lifting device of type and number required for lifting panels.

F. Perforated Panels: Provide perforated panels.

G. Grate Panels: Provide grate panels.

PART 3 - EXECUTION

3.1 PREPARATION
A. Examine sub-floor for any problems that would prevent a satisfactory installation of access floor, such as moisture an unevenness of top surface. Do not proceed with installation until sub-floor is clean, dry and level as completed by other trades.

B. Verify field dimensions to contract drawings for size of area of installation, height and level of recessed slabs, door openings, ledges, etc.

C. Floor Sealers: Verify that any concrete sealer that has been used is compatible with pedestal adhesive.

D. Access To Installation Area: General Contractor shall provide clear access to installation area throughout entire duration of installation of access floor that is free of construction debris and other trades.

3.2 INSTALLATION
A. Install access floor system and accessories under supervision of the access flooring manufactures authorized representative to ensure rigid, firm installation that complies with performance requirements and is free of vibration, rocking, rattles and squeaks.

B. Layout floor panel installation to keep the number of cut panels at the floor perimeter to a minimum.

C. Set pedestal in adhesive as recommended by the access flooring manufacturer to provide full bearing of the pedestal base on the sub floor.
1. Pedestal locations shall be established from approved shop drawings to allow mechanical and electrical work to be installed without interfering with pedestal installation.
2. Pedestals shall be attached to sub-floor using manufacturer’s approved method.
3. Secure grid member to pedestal heads in accordance with access floor manufacturer’s instructions.
4. Install floor panels securely in place and properly seated with panel edges flush. Do not force panels into place.
5. Scribe panels at perimeter to provide a close fit with adjoining construction with no voids greater than 1/180 (3 mm) where panels abut vertical surfaces.
6. Install accessories according manufacturer’s instructions.
7. Clean up dust, dirt and construction debris caused by floor installation, and vacuum the sub-floor area, as installation of floor panel proceeds. Extend cleaning under installed panels as far as possible.
8. Level installed access floor to within 0.10" (2.5 mm) over the entire access flooring area and within 0.060" (1.5 mm) of true level in any 10 ft. (3 M) distance.

3.3 ADJUSTING, CLEANING AND PROTECTION

A. During installation, all traffic on access floor shall be directed by access floor installer.
   1. No traffic, other than access floor installer, shall be allowed on the floor area for 24 hours after installation to allow the pedestal adhesive to set.
   2. No access floor panels shall be removed by other trades for 72 hours after installation.
B. After completing installation, vacuum clean access flooring.
C. Replace any flooring panels that are stained, scratched, or otherwise damaged or that do not comply with specified requirements.
D. General contractor and/or owner shall provide and maintain suitable protection to prevent damage to completed access floor throughout entire duration of installation.

END OF SECTION 096900
SECTION 26 27 27
WALL BOXES

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PART 1 GENERAL

1.1 SECTION INCLUDES

   Wall Boxes
   Specialty Boxes

1.2 REFERENCES

   A. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
   B. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
   C. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.

1.3 SYSTEM DESCRIPTION

   A. Boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Boxes are shown in approximate locations unless dimensioned.

1.4 SUBMITTALS

   A. Submit Administrative Requirements.
   B. Product Data: Manufacturer's data sheets on each product to be used, including:
      1. Preparation instructions and recommendations.
      2. Storage and handling requirements and recommendations.
      3. Installation instructions.
   C. Verification Samples: For each product specified, two samples of each device illustrating size, material, configuration and finish.
   D. Manufacturer's Certificates: Certify products meet or exceed specified requirements.
   E. Shop Drawings: Include complete layout of all wall boxes installed, specifying voice and data sockets.

1.5 QUALITY ASSURANCE

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

1.6 DELIVERY, STORAGE, AND HANDLING

   A. Store products in manufacturer's unopened packaging until ready for installation.
   B. Protect from corrosion and entrance of debris by storing above grade. Provide appropriate covering.

1.7 COORDINATION

   A. Coordinate Work with other operations and installation of finish materials to avoid damage to
adjacent materials.

B. Coordinate installation of outlet boxes for equipment connected under Common Work Results for Electrical.

C. Coordinate installation of outlet boxes for equipment connected under section Sound and Video Equipment:

PART 2 PRODUCTS

2.1 MANUFACTURERS: Manufacturer with 10 years' experience in this field. The manufacture to be approved by the engineer

2.2 WALL BOXES

A. 3 gang wall box, steel construction with a built in lock and push to open latch.
   1. Provided with mounting hardware and blank plates.
   2. Box is 3.75 inches (95 mm) deep.
   3. Finish:
      a. white or Custom Color as selected by the Architect.

2.3 SPECIALTY EQUIPMENT BOXES

A. Ceiling Boxes:
   1. Ceiling Enclosure: Designed for classrooms, conference and meeting rooms with a projector and other AV equipment.
      a. Drops into any standard drop ceiling installation and provides power switching and distribution as well as shelves to mount 2 full rack or 4 half-rack pieces of equipment above the ceiling.
      b. Enclosure provides one projector outlet facing the room and 5 switched ergonomically spaced AC outlets inside the box.
      c. Provided with fan kit.

PART 3 EXECUTION

3.1 EXAMINATION

A. Do not begin installation until substrates have been properly prepared.

B. Verify locations of floor boxes and outlets in prior to rough-in.

C. Verify openings in access floor are in proper locations.

D. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

E. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

A. Clean surfaces thoroughly prior to installation.
B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

A. Install in accordance with manufacturer’s instructions.

B. Boxes and fittings are indicated on Drawings in approximate locations unless dimensioned.

C. Orient boxes to accommodate wiring devices oriented as specified in Section 26 27 26 - Wiring Devices.

D. Set floor boxes level.

E. Install boxes and fittings to preserve fire resistance rating of slabs and other elements, using materials and methods.

F. Install wall mounted boxes at elevations to accommodate mounting heights as indicated on Drawings.

G. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.

H. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches (150 mm) separation. Install with minimum 24 inches (600 mm) separation in acoustic rated walls.

I. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.

J. Install stamped steel bridges to fasten flush mounting outlet box between studs.

K. Install flush mounting box without damaging wall insulation or reducing its effectiveness.

L. Support boxes independently of conduit.

3.4 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

3.5 ADJUSTING

A. Adjust flush-mounting outlets to make front flush with finished wall material

3.6 CLEANING

A. Clean interior of boxes to remove dust, debris, and other material.

B. Clean exposed surfaces and restore finish.

END OF SECTION 26 27 27
SECTION 27 20 00
DATA COMMUNICATIONS

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PART 1 GENERAL

1.1 SECTION INCLUDES

A. Structured cabling systems for data communication.
   1. Modular cabling systems. (Rapid Run Series)
   2. Digital cabling systems.

B. Copper network cabling. (Copper Cabling)

C. Wireless systems.

D. PC/Computer cables, devices and accessories.

E. Power cords.

1.2 RELATED SECTIONS

A. Section 07 84 53 - Building Perimeter Firestopping.

B. Section 26 05 00 - Common Work Results for Electrical.

C. Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.

D. Section 27 05 39 - Surface Raceways for Communications Systems.

1.3 REFERENCES

A. General:
   3. Occupational Safety and Health Act (OSHA).

B. Communications:
   1. ANSI/TIA/EIA - 455: Fiber Optic Test Standards.
   6. ANSI/TIA/EIA - 607: Commercial Building Grounding and Bonding Requirements for Network.
   11. IEEE 802.3 (series): Local Area Network Ethernet Standard, including the IEEE 802.3z Gigabit Ethernet Standard.
15. Underwriters’ Laboratories: UL 444 - Communications Cables.

1.4 SUBMITTALS

A. Submit under provisions of Section 01 30 00 - Administrative Requirements.

B. Product Data Submittals: Provide submittal information for review before materials are delivered to the job site. Combine product submittals for all products and submit together as a single submittal.
   1. Submit a cover letter stating that the materials shall be provided as specified, and specifically listing any items that will not be provided as specified. State in the letter that the Contractor has reviewed the specified items and agrees that they are applicable to this project in all respects.
   2. Provide standard manufacturer’s cut sheets and the operating and maintenance (Operations and Maintenance) instructions at the time of submittal review for each device in the system. These instructions shall detail how to install and service the equipment and shall include information necessary for rough-in and preparation of the building facilities to receive the materials.

C. Shop Drawings:
   1. Submit a cable routing and grouping plan as follows:
      a. Where the cable routing and grouping is to be provided as shown on the Contract Documents, do not provide a cable routing and grouping plan. Submit written documentation stating that the cable routing and grouping will be provided as shown on the Contract Documents, that the Contractor has reviewed the routing and grouping on the Contract Documents with applicable Subcontractors and suppliers and agrees that it does not create conflicts with other building utility infrastructure, and that the routing and grouping meets applicable codes, regulations and standards.
      b. Where changes in cable routing and grouping are proposed, submit complete floor plan(s) and detail drawing(s) showing the proposed routing, raceway sizes and locations, and cabling in a manner equal to that of the Contract Documents. Ensure that any cabling changes are coordinated with comparable accommodating changes to the raceway routing and grouping. Specifically note each location where the proposed routing and grouping is different from the Contract Documents. Submit written documentation detailing the reason for each change request. Each change request shall be approved in writing by the Architect prior to proceeding with the change.
   2. Submit wall field termination block and wire management elevations as follows:
      a. Where wall field termination blocks and wire management are to be provided as shown on the Contract Documents, do not submit elevations. Submit written documentation stating that the wall field termination blocks and wire management will be provided as shown on the Contract Documents, that the Contractor has reviewed the elevations on the Contract Documents with applicable Subcontractors and suppliers and agrees that it does not create conflicts between trades, and that the elevations meet applicable codes,
regulations and standards.

b. Where changes to the wall field termination blocks and wire management are proposed, submit wall field termination block and wire management elevations along with written documentation detailing the reason for the change. The change request shall be approved in writing by the Architect prior to proceeding with the change.

D. Installer Certification:
1. Documentation from the manufacturers demonstrating that the Contractor is trained and certified by the Manufacturers to install, test, and maintain the SCS and is certified by the SCS Manufacturers to provide the Manufacturer's Warranty.
2. Documentation indicating that the Contractor shall have only manufacturer-trained and manufacturer-certified employees perform installation, testing, and firestopping work, as detailed below.
   a. A list of the personnel who will be assigned to the project, the type of work they will be performing, and copies of the manufacturers' training certifications for each. If personnel changes are made during the project, submit the above information for any new personnel prior to their commencement of work on the project.
3. Documentation demonstrating that the Contractor employs a minimum of one Registered Communications Distribution Designer (RCDD) certified by and in current good standing with BICSI. The document shall declare that the RCDD is a direct full time employee of the Contractor also that the Contractor will continue to employ a minimum of one RCDD throughout the duration of the project.

E. Closeout Submittals: Provide submittal information for review as follows:
1. Operations and Maintenance Manual for Communications: At the completion of the project, submit Operations and Maintenance information from product data submittals, updated to reflect any changes during the course of construction, to the Architect in the Network-specific Operations and Maintenance Manual for Communications binder labeled with the project name and description. Provide three bound copies of the Operations and Maintenance Manual for Communications.
2. Records: Maintain at the job site a minimum of one set of Record Drawings, Specification, and Addenda. Record Drawings shall consist of redline markups of changes to Contract Documents such as drawings, specifications and spreadsheets, including maintenance hole/handhole butterfly drawings.
   a. Document changes to the system from that originally shown on the Contract Documents and clearly identify system component labels and identifiers on Record Drawings.
   b. Keep Record Drawings at the job site and make available to the Owner and Designer at any time.
   c. Keep Record Drawings current throughout the course of construction. (*Current* is defined as not more than one week behind actual construction).
   d. Show identifiers for major infrastructure components on Record Drawings.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:
1. Contractor shall be trained and certified by the Manufacturers to install, test, and maintain the SCS and be certified by the SCS Manufacturers to provide the SCS
Manufacturers' Warranties.

2. Contractor shall employ a minimum of one Registered Communications Distribution Designer (RCDD) certified by and in current good standing with BICSI. The RCDD shall be a direct full time employee of the Contractor (i.e. an RCDD consultant/sub-contractor to the Contractor is not acceptable). Contractor shall continue to employ a minimum of one RCDD throughout the duration of the project.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.7 PROJECT COORDINATION

A. Provide coordination with the cabling manufacturers to ensure that manufacturers' inspectors are available to schedule site visits, inspections, and certification of the system. Provide and coordinate any manufacturer-required modifications and have manufacturer re-inspect and certify the system prior to the scheduled use of the system by the Owner.

B. The Contractor is solely responsible for all costs associated with scheduling the manufacturer inspection, the inspection itself and any manufacturer-required re-inspections, and for any modifications to the installation as required by the manufacturers.

1.8 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.9 WARRANTY

A. Warranty: Provide manufacturer's standard warranty.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturer:

B. Substitutions: Not permitted.

C. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

2.2 SYSTEM DESCRIPTION

A. "SCS" shall mean Structured Cabling System. The SCS is defined as all required equipment and materials including (but not limited to) ANSI/TIA/EIA 568-B and ISO/IEC 11801 compliant copper station cable (Category 6) and fiber optic cable (multimode) and patch cables as specified in this section and as required for a fully operational, tested, certified,
and warranted system, compliant with all applicable codes and standards.

1. Materials required but specified in other sections are stations and station connectors, termination blocks, patch panels, racks/enclosures (such as EIA standard equipment racks, enclosures, and vertical and horizontal cable management hardware), pathway/raceway materials (such as conduit, sleeves, D-rings, surface raceway, ladder rack, cable tray, etc.), and other incidental and miscellaneous equipment and materials.

2. The system is intended to be capable of integrating voice, data, and video signals onto a common media, and shall be tested for and be capable of Gigabit Ethernet operation as specified in IEEE 802.3z.

3. Plenum HDMI cable shall comply with UL 444 and UL 910.

2.3 COPPER NETWORK CABLING (COPPER CABLING)

A. Copper Cabling:
      a. Connector: 50-micron gold plated RJ-45 male to male
      b. Conductor: Stranded copper
      c. Meets or exceeds all CAT6 ANSI /TIA 568C-2 requirements.
      d. Cables shall be warranted for a lifetime.

2.4 COMPUTER POWER CORDS

A. Computer Power Cords:

B. Extension Power Cords.
      a. NEMA 5-15P to NEMA 5-15R.
      b. 18 Awg.
      c. 13 Amp.
      d. 250 Volt.

C. Monitor Power Adapter Cords as.
   1. IEC320C14 to NEMA 5-15R.
   3. 16 Awg.
   4. 13 Amp.
   5. 250 Volt.

PART 3 EXECUTION

3.1 EXAMINATION

A. The Contractor shall be solely responsible for the safety of the public and workers in accordance with all applicable rules, regulations, building codes and ordinances.

B. The Work shall comply with applicable safety rules and regulations including OSHA. The Work shall comply with the requirements of the National Electrical Safety Code (NESC) and the NEC except where local codes or regulations are more stringent, in which case the local codes or regulations shall govern.
C. The Work shall comply with the requirements and recommendations of the product manufacturers. Where questions arise regarding which requirements and recommendations apply, the more stringent shall prevail.

D. Replace or repair to original (or better) condition any existing structures, materials, equipment, etc. inadvertently demolished or damaged by the Contractor during the course of construction at no additional cost to the Owner.

E. Remove surplus material and debris from the job site and dispose of legally.

F. Do not begin installation until substrates have been properly prepared.

G. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 INSTALLATION - GENERAL

A. Install in accordance with manufacturer's instructions.

3.3 CABLE INSTALLATION

A. General (applicable to all cable types): Provide non-plenum (CM/CMR, OFNR) rated cable for locations where cable is to be installed in conduit. For cable not installed in conduit, provide plenum (CMP, OFNP) rated cable if cable is installed in a plenum air space environment, non-plenum rated otherwise. Cabling shall bear plenum or non-plenum markings for the environment in which it is installed.

1. For Horizontal Distribution: Provide station cable in types, sizes, and quantities as shown on the Contract Documents. Install cable between the station and its associated Network room. Provide one cable per each connector at each station. Provide cables of the same type in the same color - multiple colors of the same cable type are not acceptable.

2. For Intrabuilding Backbone Distribution: Provide intrabuilding backbone cable in types, sizes, and quantities as shown on the Contract Documents. Install intrabuilding backbone cables between server room and wireless access point within the same building. Provide cables of the same type in the same color - multiple colors of the same cable type are not acceptable.

3. Install cable in compliance with ANSI/TIA/EIA and ISO/IEC 11801 requirements and BICSI TCIM practices.
4. Adhere to the bending radius and pull strength requirements as detailed in the ANSI/TIA/EIA standards and the manufacturer's installation recommendations during cable handling and installation.
   a. Pull all cables simultaneously where more than one cable is being installed in the same raceway.
   b. Use pulling compound or lubricant where necessary. Use compounds that will not damage conductor or insulation (Polywater, or approved equal).
   c. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage media or raceway. Repair or replace conduit bushings that become damaged during cabling installation.

5. Install cable in a continuous (non-spliced) manner unless otherwise indicated.
6. Install exposed cable parallel to and perpendicular to surfaces on exposed structural members and follow surface contours where possible.
7. Tie or clamp cabling. Attaching cables to pipes, electrical conduit, mechanical items, existing cables, or the ceiling support system (grids, hanger wires, etc.- with the exception of ceiling support anchors) is not acceptable. Install tie-wraps in conformance with the SCS manufacturer's installation recommendations. Do not overtighten tie wraps or cause cross-sectional deformation of cabling.

8. Cable at the backboards:
   a. Lay and dress cables to allow other cables to enter raceway (conduit or otherwise) without difficulty at a later time by maintaining a working distance from these openings.
   b. Route cable as close as possible to the ceiling, floor, sides, or corners to insure that adequate wall or backboard space is available for current and future equipment and for cable terminations.
   c. Lay cables via the shortest route directly to the nearest edge of the backboard from mounted equipment or blocks. Support cables so as not to create a load on the equipment upon which the cables are terminated. Tie-wrap similarly routed and similar cables together and attach to D-rings vertically or horizontally, then route over a path that will offer minimum obstruction to future installations of equipment, backboards or other cables.

9. Cable in the Network rooms:
   a. For Network rooms with ladder rack, lay cable neatly in ladder rack in even bundles and loosely secure cabling to the ladder rack at regular intervals with tie-wraps or velcro straps.

10. Cable terminating on patch panels located on racks:
    a. Route cables in Network rooms to patch panels on racks by routing across ladder rack across top of rack and then down vertical ladder rack to patch panel.

B. Copper Cable: Terminate all pairs within a cable. Un-terminated cable pairs are not acceptable.

1. For horizontal distribution: Provide station cable in the locations shown on the Contract Documents. Provide service loops with a minimum length of 12 inches in outlet boxes and no less than 10 feet in the ER/TR's.
   a. Route station cable that is exposed (not in conduit) to comply with ANSI/TIA/EIA-569 requirements for avoiding potential EMI sources and as follows:
      1) 48 inches (1219 mm) from motors or transformers.
      2) 12 inches (305 mm) from conduit and cables used for electrical power distribution.
      3) 5 inches (127 mm) from fluorescent lighting.

2. For intrabuilding backbone distribution: Install intrabuilding backbone cable in the locations shown on the Contract Documents. Provide a service loop long enough in the TR's to reach termination equipment if moved to the farthest side of the room in the future, but no less than a minimum length of 10 feet (3.3 m) at each end.
   a. Use unshielded, non-plenum multi-pair copper cable for connecting the back side of termination blocks to entrance protectors, telephone systems, and voice grade active electronics.
   b. For shielded cable, bond both ends of the metallic shield (or metallic strength) member to the nearest TGB as furnished under Section 26 05 48 - Vibration and Seismic Controls for Electrical Systems.
3.4 CABLE ASSEMBLIES (PATCH CORDS) AND CROSS-CONNECTS

A. Furnish copper patch cables for modular copper cross-connects. Deliver patch cables to Owner in the sizes, colors and quantities as scheduled.

B. Furnish hook-and-loop cable managers for managing patch cords in the Network rooms. Provide in colors, sizes and quantities as indicated below. Cable managers shall be the same color as the patch cable type that they manage.

3.5 LABELING AND ADMINISTRATION

A. General: Labeling and administration shall comply with ANSI/TIA/EIA 606 and standard industry practices.

B. Color Coding: Apply industry standard color coding to cable termination fields. Always apply the same color at both ends of any given cable. Cross-connections are generally made between termination fields of different colors. The color may be applied to the backboard behind the termination equipment, may be the color of a cover on the termination equipment, or may be the actual color of the insert label on the termination equipment.

C. Racks: Label racks as shown on the Contract Documents. Affix label centered across top cross-member of rack.

D. Cables:
   1. Label Location: Affix at each end of the cable.
   2. End device Cables: Label end device cables with the same label as the server room connector (see SERVER ROOM CONNECTORS (PORTS) below) that terminates the cable at the end device location. Include a clear vinyl adhesive wrapping applied over the label in order to permanently affix the label to the cable. Using transparent tape to affix labels to cables is not acceptable.
   3. Copper Backbone Cables: Label intrabuilding copper backbone cables in the form "C (TR to TR), ###-PR, CAT##, ###-FT " where "C" stands for media type ("C" for "administrative copper" media), "(TR to TR)" is the origination and destination Network rooms between which the cable routes, "###-PR" is the pair count, "CAT##" is the cable type (i.e. CAT3 or CAT5E), and ###-FT is the cut length.
   4. Provide labels at each end of each cable within 24 inches (610 mm) of server room entrance and again within 24 inches (610 mm) of termination point.

E. Termination Blocks:
      b. Label termination strip pairs sequentially (left to right).
   2. For Horizontal Distribution: Label termination blocks used for horizontal distribution with a single label affixed above the entire termination block column indicating the room number on which the outlets are located, whose cable terminates on that column.
      a. Termination strip pairs shall be of the form "###" where "###" denotes the sequential cable number terminated.
   3. For Backbone Distribution: Label termination blocks used for backbone distribution with a single label affixed above the entire termination block wall field which reads
"Backbone". Additionally, label each termination block column within the termination block wall field.

F. Patch Panels:
   1. For Horizontal Distribution:
      a. General: Label patch panels as shown on the Contract Documents.
      b. Ports: Ports are typically pre-labeled by the manufacturer with sequential numbers (i.e. 1 to 48). For ports which are not pre-labeled, label port in the form "##" where "##" is the sequential port number within the panel. Each patch panel shall start at port number "01".

G. Conduits: Label each conduit end (existing or new) in a clear manner by designating the location of the other end of the conduit (i.e. room name, pull box identifier, outlet identifier (use the label of the first port of the outlet as the outlet identifier), etc.). Indicate conduit length on the label.

H. Pull Strings: Label each pull string in a clear manner by designating the location of the other end of the pull string (i.e. room name, pull box identifier, outlet identifier (use the label of the first port of the outlet as the outlet identifier), etc.).

3.6 TESTING

A. Provide test records on a form approved by the Architect. Include the test results for each cable in the system. Submit the test results for each cable tested with identification as discussed under LABELING AND ADMINISTRATION above. Include the cable identifier, outcome of test, indication of errors found, cable length, retest results, and name and signature of technician completing the tests. Provide test results for review and acceptance within two weeks of Substantial Completion.
   1. Print test records for each cable within the system directly from the tester and submit in paper form (in a binder) and in electronic form (on flash disk or CDROM) to the Owner and Designer for review. Handwritten test results will not be accepted.

B. Test the SCS after installation for compliance to all applicable standards as follows:
   1. Copper:
      a. For Horizontal Distribution: Test all pairs of each copper station cable, for conformance to ANSI/TIA/EIA 568-B Category 6, and ANSI/TIA/EIA 568-B standards. To the extent possible, perform tests with building electrical systems fully powered on.
         1) Test each end-to-end link (the entire channel from the connector at the station to the connector utilizing sweep tests, for continuity, shorts, polarity, near-end cross talk (NEXT), far-end cross talk (FEXT), attenuation, installed length, transposition (wire map), mutual capacitance, characteristic impedance, resistance, ACR, and presence of AC voltage. Use the Power Sum method to test NEXT and FEXT. Test each cable in both directions.
         2) Use a TIA/EIA Level III testing instrument, re-calibrated within the manufacturer's recommended calibration period, with the most current software revision based upon the most current ANSI/TIA/EIA testing guidelines, capable of storing and printing test records for each cable within the system and equipped with the current test adapters.
            a) Testing Device: Fluke DSP-4000 or equivalent with latest software.
and hardware releases for CAT-6 horizontal distribution cables, or approved equal.

3) In addition to the above, perform tests both recommended and mandated by manufacturer. Tests shall confirm/guarantee compliance to Ethernet Category 6 1000B-T (1000 Mb/s IEEE 802.3ab) and 1000B-TX (1000 Mb/s ANSI/TIA/EIA-854) applications.

b. For Intrabuilding Backbone Distribution: Test all cable pairs for length, shorts, opens, continuity, polarity reversals, transposition (wire map), and the presence of AC voltage. All pairs shall demonstrate compliance to TIA/EIA 568-B Category 3 standards.
   1) Test copper cable on the reel upon delivery to the job site, again prior to installation, and again after installation.
   2) Test entire channel, from termination block to termination block.
   3) Use a TIA/EIA Level III testing instrument, re-calibrated within the manufacturer's recommended calibration period, with the most current software revision based upon the most current TIA/EIA testing guidelines, capable of storing and printing test records for each cable within the system.
      a) Fluke DSP-4000, or approved equal.

3.7 FIRESTOPPING

A. Only employees trained/certified by the firestopping manufacturer shall apply firestopping materials.

B. Maintain fire rating of penetrated fire barriers. Fire stop and seal penetrations made during construction.
   1. Provide firestopping material for through and membrane penetrations of fire-rated barriers.
   2. Install firestops in strict accordance with manufacturer's detailed installation procedures. Refer to Section 07 84 53 - Building Perimeter Firestopping.
   3. Install firestops in accordance with fire test reports, fire resistance requirements, acceptable sample installations, manufacturer's recommendations, local fire and building authorities, and applicable codes and standards. Apply sealing material in a manner acceptable to the local fire and building authorities.
   4. For demolition work, apply firestopping to open penetrations in fire rated barriers where cable is removed. Apply firestopping regardless of whether or not the penetrations are used for new cable or left empty after construction is complete.
   5. Firestopping material used to seal open penetrations through which cable passes shall be re-usable/re-enterable.

3.8 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

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PART 1 GENERAL

1.1 SECTION INCLUDES

A. Active electro-acoustic system for performance venues and music rehearsal rooms.

1.2 RELATED SECTIONS

A. Section 01 35 00 - Special Procedures.
B. Section 06 10 00 - Rough Carpentry.
C. Section 09 22 16.13 - Non-Structural Metal Stud Framing.
D. Section 09 51 23 - Acoustical Tile Ceilings.
E. Section 09 84 36 - Sound-Absorbing Ceiling Units.
F. Division 16 - Electrical for power wiring.

1.3 REFERENCES

A. ASTM International (ASTM):
   1. ASTM C 423-84a - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.

B. Underwriters Laboratories, Inc. (UL):
   1. UL 1480, UL 2043 - Fire Test for Heat and Visible Smoke Release for Discrete Product and Their Accessories Installed in Air-Heating Spaces

1.4 DEFINITIONS

A. Transcend Active Acoustics System: A patented, digital signal processing, time-variant synthetic reverberation system designed for performance venues.

B. VAE Rehearsal System: A patented, digital signal processing, time-variant synthetic reverberation system designed for rehearsal spaces.

C. VAE Virtual Shell System: A patented, digital signal processing, time-variant synthetic early reflection and reverberation system designed for stages.

1.5 SYSTEM DESCRIPTION

A. System Components.
   1. speakers:
      a. Wall mounted.
      b. Ceiling mounted.
      c. Subwoofer.
   2. Microphones:
a. Wire Microphones - cardioid.
b. Wireless microphones - cardioid.


4. Amplifiers:
a. Amplifiers; network control - 2500W/channel.

5. Digital signal processor.

6. Control Panel System:
a. Touch screen control panel.
b. Wall control.
c. Touch screen control panel.

7. Power sequencer.

8. Equipment rack(s).

9. Digital Signal Processor:
a. Signal Processor.
b. Others available as required.

10. Design Requirements:
a. Includes multiple preset acoustic enhancement programs developed in conjunction with the end user.
b. Simple, intuitive operation.

B. VAE Rehearsal System Components:
1. Digital signal processor.
2. Amplifier:
a. 125W/channel.

3. Speakers:
a. Wall mounted.
b. Ceiling mounted.

5. Control panel.
6. Power sequencer.
7. Equipment rack.

C. Shell System Components:
1. Digital signal processor.
2. Amplifier:
a. 125W/channel.

5. Control panel.
6. Power sequencer.
7. Equipment rack.

1.6 SUBMITTALS

A. Submit Administrative Requirements.

B. Product Data: Submit applicable reference standards, current performance data, and application recommendations and product limitations.

C. Shop Drawings: Submit assembly and installation layout drawings showing product components in assembly with adjacent materials and products (speakers, panels,
microphones, electronics rack).

D. Operation and Maintenance Data.

E. Warranty: Submit manufacturer's standard warranty statement.

1.7 QUALITY ASSURANCE

A. Manufacturer Qualifications: Minimum 5 years experience in manufacture of similar products in use in similar environments, including project size, and complexity, and with the production capacity to meet the construction and installation schedule.

B. Installer Qualifications: Installation, disassembly, re-assembly and calibration shall be done by manufacturer employed or approved subcontractors.

C. Source Limitations: Obtain components and accessories through one source from a single approved manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Pack and ship in accordance with manufacturer's recommendations:
   1. Finish, assemble, and test all components in the factory before shipment.
   2. Rack components will be sub assembled before delivery to jobsite.
   3. Deliver components to room designated for installation.

B. Damaged products at the site not accepted. Do not install damaged products.

C. Store products in heated indoor storage near point of installation. Retain protective packaging until installing. Ship to jobsite only after roughing-in, painting work, and other related finish work has been completed and installation areas are ready to accept units and recommended temperature and humidity levels will be maintained during the remainder of construction.

1.9 PROJECT CONDITIONS

A. Environmental Requirements: Do not install system until all mortar, wet and dust producing trades have completed their work and finished floor is in place.

B. Determine with the customer rack location(s).

C. Where code permits, wiring may be run outside of conduit. Such wiring shall be coordinated either in a plenum space or by means of secondary enclosure that meets code requirements.

D. Customer will arrange to assure the noise level in the rehearsal space is at or less than NC 30.

E. Field Measurements: Obtain required field measurements and indicating performance setups, ceiling construction, wall construction, ventilation features, electrical systems, networks and potential obstacles on shop drawings.

1.10 WARRANTY
A. Manufacturer's written warranty indicating manufacturer's intent to repair or replace components of system that fail in materials or workmanship from date of Substantial Completion for the number of years indicated below. Repair of replacement shall occur within 30 days following report of such defects by the Owner.
1. Warranty should be 3 years.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer with 10 years' experience in this field. The manufacturer to be approved by the engineer

2.2 Sound SYSTEM

A. Control Panels:
1. Wall mounted (single or dual gang) Ethernet wall controller; PoE (power over Ethernet), configured with Audio Architect, 8 programmable buttons, security: remote lock/unlock, local lock/unlock (with PIN entry), Cable length up to, 100m/300ft, low power consumption.

B. Microphones:
1. Frequency response: 35 to 20,000 Hz; sensitivity at 1,000 Hz - 20 mV/Pa (-34 dBV), equivalent noise level: 13 dB-A, SPL for 1% THD: 142 dB.

C. Microphone Converter:
1. Analog Inputs: 16 electronically balanced removable screw connectors, Mic/Line Inputs: Nominal gain 0dB, electronically switchable up to +48dB, in 6dB steps, Input Impedance: 3.0kOhm, Input Noise (E.I.N): < 123dBu typical with 150 Ohms source, Power: selectable per input, A/D Latency: 37/Fs (0.77ms@48k, 0.39ms@96k), Digital Audio Bus: Connectors: 2 x RJ45 Ethernet connectors, Cable Length up to: 100m/300ft on Category 6e cable between devices, Maximum Number of Nodes: 60, Latency: 11/Fs (0.23ms@48k, 0.11ms@96k), Pass Through Latency: 4/Fs (0.08ms@48k, 0.04ms@96k),

D. Active Processor:
1. Processor: System: 48kHz, 32-bit floating point, Digital Inputs/Outputs: Inputs: 16 microphone, 8 auxiliary, Outputs: 32, Link Audio Network: Connectors: @x Ethercon lockable RJ45 Ethernet, Cable Length up to: 100m/328ft on Category 6 cable between devices, Maximum number of Nodes: 60, Maximum Number of Channels: 256 at 48kHz, 128 at 96kHz, Latency: 11/Fs (0.23 msec at 48kHz), Pass-Through Latency: 4/Fx (0.08,sec at 48kHz) Front Panel Indicators: LED Meter: Clip (-3dBFS, -10dBFS, -20 dBFS, -50 dBFS, (dBFS = dB Full Scale), Ethernet: Connector: RJ45, Cable Length up to: 100m/328ft on Category 6e cable between devices, Communication Applications: Harman Audio Architect, USB Port: Connector: Mini- B, Power and Dimensions: Timelag Hi Brk, Rack Units: 2U, Temperature: 0 to 40 C (32 to 104 F), Humidity: 95% max,

E. Amplifiers:
1. Networked Amplifier

F. Speakers:
1. Wall Mounted. Frequency response (-10dB) half space wall: 60 Hz to 16 kHz, continuous program power capacity: 175 Watts, sensitivity: 92 dB SPL, polypropylene cone with WeatherEdge, HF drive: 25mm titanium coated polycarbonate, enclosure material: high impact polystyrene, overload protection: full-range power limiting to protect network and transducers, termination: spring clips, accepts banana plugs, environmental: conforms to Mil Spec 810 for humidity, salt spray, temperature and UV, IEC 529-X4 splash proof rating.

2. Ceiling mounted; Frequency response (-10dB) half space flush to ceiling: 75 Hz to 20 kHz, continuous program power capacity: 150 Watts, sensitivity: 89 dB SPL, 1W, 1m, nominal coverage angle: 110 degree conical coverage, directivity factor (Q): 5.9 averaged 500 Hz to 4 kHz, directivity index (DI) 4.6 averaged 500 Hz to 4 kHz, maximum rated SPL 107 dB @ 1m, nominal impedance: 16 ohms, LF driver: 165 mm polypropylene coated, HF drive: 19mm titanium coated polyester, enclosure material: back can; formed steel, baffle/rim: medium impact polystyrene, fire rated UL94V-0 overload protection: full-range power limiting to protect network and transducers, termination: removable locking connector with screw-down terminals, safety agency rating: suitable for use in air handling spaces per UL1480, UL2043, NFPA90 & NFPA70, cut out size 8.75 inches (220 mm), weight: 7.5 lbs (3.4 kg).

G. Digital Signal Processors:
1. Inputs: 64 analog, nominal gain 0dB, electronically switchable up to +48 dB in +6dB steps, input impedance: 3.5k ohms, maximum put level: +20 dBu with 0dB input gain, +8dBu with 12 dB gain, CMRR: > 45dB at 1kHz, input noise: <-128dBu typical with 150 ohm source, A/D latency: 29/Fs (0.60ms@48kHz), outputs: 64 analog with an output level up to +20dBu, frequency response 20Hz to 20kHz (+0.5dB/-1dB), THD: 0.005% typically at +4dBu, 1Khz, 0dB input gain, dynamic range: 110dB, A-weighted, >107dB unweighted, crosstalk: <-100dB, D/A latency 29/Fs (0.60ms@48kHz), control ports: 12 inputs and 6 outputs; control network: connectors: RJ45 Ethernet connectors, maximum cable length: 100m/300ft on Category 6 cable between device and Ethernet switch, BLU link: connectors: 2 x RJ45 Ethernet connectors, Maximum cable length: 100m/300ft, on Category 6 cable between devices, Max. number of nodes: 60, Latency: 11/Fs (0.23ms@48k), Pass Through Latency: 4/Fs (0.08ms@48k), Power consumption: < 55VA, BTU rating: 188 BTU/hr, Operating temperature range: 5 (41) to 35 (95) degrees C (degrees F).

H. Network Switch:
1. Gigabit Smart Switch.

I. Locking Switch Set:
1. Single rack plate with a locking switch.

2.3 Control Panel

A. Control Panel: Wired, 32 button, backlit control panel with digital display. Includes preset environments and customizable environment setting. Also includes record/playback function for immediate playback, and uploading /downloading of data to and from a computer.

B. Digital Processor: Processor with built-in pre-amplification and equalization. Microphone Inputs: Female XLR, Input Impedance: 3000 Ohms Balanced, Frequency Response: 20 to 20 kHz within 1dB THD+N: 0.007%, Sample Rate: 44.1 kHz, Dynamic Range: A/D > 100 dB, 24 Bit resolution, D/A > 100 dB, 24 Bit resolution, Record Output: 1/8’ TRS jack, Outputs:
Four 1/4’ TRS and 4-pin EURO (5.08mm pitch), Output Impedance: 4/8 ohms, Remote control connector: 10-pin Molex, USB type B socket: For downloading recorded files, Compact Flash socket: For storing recorded sessions, Internal 15-band 2/3 octave Equalizer, Internal pink noise generator and real-time analyzer.

C. Amplification: Channels: 16/32, sensitivity: 1.4V (26dB gain), rated power output: 125W per channel into 8/4 ohms, signal to noise ratio (below rated power 20Hz to 20kHz, A-weighted) 110 dB, total harmonic distortion (THD)(full rated power, 1kHz): < 0.05%, intermodulation distortion (from 0dB down to -30dB): < 0.05%, frequency response (at 1W into 4/8 ohms): +/-0.5 dB, common mode rejection (20Hz to 1kHz): > 70 dB, load ranges: 4-160 ohms.

PART 3 EXECUTION

3.1 EXAMINATION
   1. Transformer Isolation: Required.

3.2 INSTALLATION
   A. All components should be manufactured units, pre-wired where appropriate.
   B. Calibrate system for proper operation.
   C. Acceptance Testing shall be performed during a period designated and agreed upon by all parties. The minimum time required for Acceptance Testing is five working days of dedicated quiet. Following the testing period, the owner or consultant will work with the contractor for final tuning and acceptance.

3.3 DEMONSTRATION
   A. Train Owner’s personnel to operate, and maintain
   B. Turn over operation and instructions to Owner.

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GENERAL

1.1 SECTION INCLUDES
   A. Security/Perimeter Access Control System.
   B. CCTV Digital Surveillance System.

1.2 RELATED WORK
   A. Surveillance and control devices identification as specified elsewhere.
   B. Providing all cabling, conduit and connections as required for complete and functional systems as specified elsewhere.
   C. Providing uninterruptible power as required for all equipment provided under this section as specified elsewhere.
   D. Assemble equipment furnished disassembled in accordance with manufacturer's recommendations as specified elsewhere.
   E. Providing door hardware for remote monitoring and control of openings as scheduled under this section as specified elsewhere.

1.3 SYSTEM DESCRIPTION - SECURITY/ACCESS CONTROL SYSTEM
   A. Access Control: Building and selected areas using proximity cards, magnetic swipe, barcode, or biometric identifiers.
      1. Exterior Doors: Control access into building at locations as shown on drawings.
      2. Restrict Access of individual credential-holders by time of day, day of week/month/year and specific points of entry via user-configurable software.
      3. Unlock Doors to building and selected areas automatically, where shown on drawings, for a scheduled period of time throughout the day allowing free access and egress without the use of a card and avoiding the generation of an alarm condition on the access control system. The system GUI computer operator shall be able to unlock doors from the computer system.
      4. Monitor Points in building and selected areas as shown on drawings that may provide unauthorized access or egress and may be a point for forced entry. The system shall report changes in status for all monitored points indicating the specific location so the operator can respond appropriately.
      5. Photo Identification for all credential-holders to be stored in conjunction with database information.
      6. Provide graphical display of building maps with dynamic display of door status and alarms on all access control workstations.
      7. Provide report generation for all alarm signals.
      8. Security system should be compatible with the Bank standard security system.
   B. System Interface: Shall provide a real-time display of all alarms and system events, archive all events in a history file to a relational database and serve as the instrument through which all system programming is accomplished. Computer/Workstation shall be configured for the intended system function by loading the appropriate services and operating system software.
1. Security Monitoring Station Computer: Shall be installed in primary security office control or as instructed by the owner.

2. Station Computer: Shall be installed in administration or as instructed by the owner and connected to the PC Network by Ethernet/LAN. The Station Computer shall run the system software, be password protected and be able to enter, edit, and delete card members. The system server shall also have the operating system for the access control software. The system shall have a TWAIN interface for photo capture and connection to a dye-sublimation printer for credential issuance.

C. Central Database Server: The service shall provide a connection between the Central Database Server all Access Control Panels (ACP’s). The connection to the ACP's will be over a Local Area Network (LAN) connection. The central system will provide real-time transactional storage of all system events, archive time configured events into a separate Archive Database serve as the instrument through which all system programming is stored.

D. Access Control Panels shall be installed in the equipment rooms as indicated on the Contract Documents, communicating to the Central Server over a local LAN connection. The ACP's shall connect to all reader and alarming devices. The system shall provide:

1. Access Control: to building using proximity cards, magnetic swipe, barcode and biometric scanners.

1.4 SYSTEM DESCRIPTION - CCTV DIGITAL SURVEILLANCE SYSTEM

A. System shall be fully capable of all hardware and software functionality for a surveillance, and alarming system. Single systems shall be capable of operating in network interconnected multi-system configuration without additional hardware or software.

1. The software shall be a recognized tool capable of operating with alarm systems and security monitoring centers, producing court-admissible video evidence for use by officials and law enforcement.

2. System shall be available to support up to 16 cameras in various frame rate speeds from 30 frames/second per system to 30 frames/camera.
   a. The camera connectivity and frame-rate performance shall use the identical application software and interconnect seamlessly using a single remote access software utility. Stored video shall be interchangeable from any one system to another.

3. Systems shall be interchangeable and be connectable through the same Remote Access Software within a security management system, regardless of the scale or system configuration.

4. System shall be configurable in a desktop, desk side, rack mount for indoor use in a space appropriately conditioned for computer equipment.

5. Network interconnected, multi-system configurations shall be capable of being created from the standard single-system configuration without additional hardware or software to integrate multiple systems. Application software shall allow multiple network interconnected systems, to be concurrently accessed by remote users on a single screen.

1.5 SUBMITTALS

A. Submit Administrative Requirements.
B. Product Data: Manufacturer's data sheets on each product to be used, including:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Installation methods.

C. Shop Drawings: Include system components and controls, installation requirements, and relationship with adjacent construction.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Company specializing in manufacturing the products specified with minimum 20 years documented experience, and with a certified servicing organization.
   2. Manufacturer shall be capable of providing through its resellers a sole-source, turn-key solution including, but not limited to system server, customary cameras, wiring, networking components, and other peripherals essential for operation of the solution.
   3. Manufacturer shall be directly accessible to end users for advice on service, support, and warranty issues. Manufacturer shall maintain support information for public access on a web site and facilitate contact with technical resources.
   4. Software updates shall be freely accessible for download from the manufacturer's web site and available at no charge. Terms for release of software revisions offering substantially new capabilities shall be offered for sale at the discretion of the manufacturer.
   5. Manufacturer's operation manual and training tutorials shall be directly accessible through the system server main menu and provided on PC-compatible CD for installation on any personal computer. The manual and tutorial shall provide for intuitive topic search and help for system operation and function explanations. Additional computer support and help utilities shall be included on the system server main menu to assist in managing functions such as multi-media control, file management, disk and media management, file authentication, backup and more.

B. Installer Qualifications:
   1. Company specializing in installing the Products specified in this section and Related Work with minimum five years documented experience. Experience shall include projects with access control systems of similar scope and magnitude. Company shall be a Certified Dealer of the manufacturer.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store products in manufacturer's unopened packaging until ready for installation.

B. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

1.8 PROJECT CONDITIONS

A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
1.9 COORDINATION

A. Provide system including network computers, controllers, credential readers, credentials and badging station.

B. Provide detection devices.

C. Connect electric strikes and monitor status of door controls.

D. Provide request for egress Passive Infrared Detectors (PIR) and pushbuttons.

E. Provide all required power supplies. Provide all cabling connections required. Provide all specialty conduit requirements. Coordinate with the Electrical Contractor.

F. The security contractor in coordination with the door hardware supplier shall provide the security components as scheduled and indicated on the Contract Drawings.

1.10 WARRANTY

1. Provide a full performance and material guarantee for two years from the final acceptance of the system. The warranty shall be unconditional and include all manufacturer hardware material to maintain the system in operational condition.

B. CCTV Surveillance System:
   1. Resellers shall include direct manufacturer 3-year on-site warranty service with additional services such as manufacturer setup available. Response shall include same-day, next-business-day, or as available.
   2. Manufacturer's warranty shall include 30-day exchange for new equipment from the reseller's invoice date and one year depot parts and labor repair for systems not having had the terms of the warranty voided. Extended warranty contracts shall include extended term and hot-swap provisions.
   3. Ownership Rights and Privileges:
      a. The system software application license shall be totally user-owned and user-supportable with complete documentation files provided for duplication at will. Reproduction of remote viewing software shall be allowed to enhance the flexibility of remote access to the camera server.
      b. Software support or server maintenance will be required for one year. The processor system shall optionally include extensions of warranty.
      c. Software point releases, which may include enhancements, shall be available whenever possible and be capable of being downloaded from a central support web site. Version upgrades shall be available at nominal charges determined by the manufacturer.
      d. The manufacturer shall maintain an internet WEB site help center with FAQ assistance and software download center with e-Mail access to technical support.
      e. The server software shall be able to query the manufacturer's web site, compare the latest versions of software available, and administer the download and automatic installation of the new software versions on a scheduled basis.

1.11 SPECIAL TOOLS, EQUIPMENT AND MATERIALS
A. The Contractor shall deliver to the Owner's representative all special tools, equipment and materials necessary to maintain the system provided. A list of all special tools, equipment and materials associated with each system shall be submitted to the Owner minimum 2 weeks prior to final acceptance test.

1.12 ADDITIONAL MATERIALS

A. Contractor shall provide the following spare equipment for items scheduled:
   1. 05 card readers.
   2. 05 PIR egress device.
   3. 05 DPI (Dual Port Interface).
   4. 05 door position contacts.
   5. 20 cards - one side printed, as directed by the Owner, one side blank.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer with 10 years experience in this field. The manufactural to be approved by the engineer

2.2 CCTV DIGITAL SURVEILLANCE SYSTEM

A. The system server and software capabilities shall consist of the following components and facilitate camera connection, administer the control program, create sequential and multiplexed camera displays, store recorded video, provide for computer assisted search and playback, and facilitate for authorized connection from remote computers.
   1. System

B. Installation of the system shall include battery backup and power conditioning for server and cameras with auto-recovery upon restoration of main power.

C. Hardware: Digital Camera Server hardware shall directly support connection of up to 16 camera video streams to an industry-standard based computer platform. All components shall be termed industry standard and PC-compatible including the proprietary video capture and digitizing components. System components and capabilities shall include:
   1. Industry standard operating system capable of being self-supported with standard knowledge of PC operating systems, applications and networking. System application software shall use industry standard program interfaces to the operating system. Applications installed in the system shall be self starting and self recovering in the event of a power failure or software conflict.
   2. Standard storage devices in the System shall be industry standard, PC-compatible and configurable to user requirements. These include, but are not limited to installed commercial quality hard disk drives, a high-speed rewritable CD-ROM drive.
      a. Supported storage devices shall include removable disks, DVD writer, external storage devices, and networked storage media.
   3. Primary video shall be displayed in multiplexed configurations of live camera video streams, with program controls, feature icons, and operation indicators using an industry-standard, PC-compatible display of the user's choosing.
      a. The system shall offer high-resolution, full-motion (30 frame/second/camera)
overlayed and multiplexed display. PC-compatible accessories shall be able to expand the primary display.

4. Video output shall be provided for display on television monitors of the user's choice.

5. PC-compatible keyboard and mouse pointing device shall be the standard input method. The application shall provide for on-screen graphic keyboards for any alphanumeric information making the keyboard unnecessary as an input device on the desktop.

6. Communications connection shall include a standard TCP/IP network connection ports tested and configured for immediate activation on the site's LAN or WAN.
   a. Modem shall be configured for dial-up connection to the System server. Both methods of connection shall be capable of being connected concurrently.
   b. A video and alarm contact closure connection shall replace the standard video cable connectors provided with each system.

7. A microphone input to monitor and record a single audio channel shall be provided with all systems.
   a. Up to eight channels of audio shall be capable of being monitored and synchronously imbedded with the recording of video depending upon the resources of the System specified.

8. Camera control commands to specified camera brands shall be communicated through an optional interface transmitting the directional commands from the system on-screen control program to the camera according to the camera manufacturer's specifications.

D. Software:
   1. Main Monitoring Software Display Capabilities:
      a. The primary purpose of the main monitoring screen shall be to display on a PC compatible CRT all video streams from connected cameras. Up to 16 concurrent screens shall be displayed in choices of arrays capable of being expanded to full screen to hide operating controls of the system. Screens shall be able to auto-rotate between partial displays of the total number of cameras.
      b. The main screen shall display time and date as well as time and date of the oldest recording stored in the system files, status of the backup utility, status of the alarm notification status, network connectivity status.
      c. Camera connection and recording status shall be indicated by visual color coding for quick identification of activity. In addition, an audible alert shall should a connected camera fail to deliver video to the system.
      d. Graphic control shall be accessible from the main display with password authorization required to modify camera viewing. Supported PTZ cameras listed in the settings menu shall allow directional control, zooming control, and focus control. An auto-program mode or preset position selections shall be available should the camera brand support additional computer controlled functions. PTZ camera control shall also be supported over network remote access connections.
      e. On-screen control of 360-Degree cameras for live, remote, and recorded video without the need of motorized PTZ cameras.
      f. Quick Search shall allow immediate access to the most recently recorded events from the main monitoring screen.
g. Access to Settings Menus and Search Menus shall be accessible from the main display with password authorization required to enter these protected areas of the System control and operation.

h. Monitoring and recording shall not be interrupted by the use of any function on the main monitoring display.

i. Exit and shutdown of the System from the main monitoring display shall be a password protected function.

2. Video Search and Playback. This password protected function of the System shall offer fast and intuitive access to video stored on the system media based upon date and time face recognized, using a point-and-click graphical screen display from either the main system or through the Remote Monitoring Software. Use of the Search program shall not interrupt the full operation of the System.

3. The Video Search Software provided with the digital surveillance system will not be restricted from being copied or freely distributed and can be operated on any compatible PC with a minimum configuration.

4. Playback functions shall include:
   a. Fast and intuitive access to stored video files using a calendar based tool identifying the presence of video on a selected camera by color coding of calendar days, in hours of a day, and in minutes of an hour. A full frame of the first frame of video available shall immediately appear. Color coding shall indicate the method of recording and if audio is integrated into the video stream selected.
   b. Display of single or concurrently playing streams, up to a full 16 streams shall be supported as well as increase of frame size for single streams. Images shall offer digital zoom enlargement to the extent of the useful clarity of the original recorded image.
   c. Information on each frame displayed in a single stream shall include the name of the server on which the video was recorded, the method of recording (JPG or H.263), the recording resolution, and frame size in Kbytes of each frame.
   d. Control of playback shall be graphically presented similar to VCR controls. Forward, stop, frame-at-a-time, end of clip, and reverse play shall be point-and-click were the video stream supports each function.
   e. Choice of playback functions shall include control of images to enhance their appearance such as sharpening, blurring, conversion to monochrome, adjustment of brightness, contrast and color, fine adjustments of the playback speed from faster to slower than originally recorded, and playback or muting of audio imbedded in the recording.
   f. Duplication of stored video into an industry-standard, MS-Windows Media Player compatible single-frame .JPG or streaming .AVI format shall create copies to the installed CD-RW drive or any connected storage location or device.
   g. .JPG images shall be capable of being directly printed from the system to a PC-compatible printer with drivers loaded on the server by the user.
   h. Motion Search functions shall allow identifying of a selected target area of recorded video and auto-advancing the video stream to the next time when motion occurs within the identified target area of the video. A table of events shall be created to identify search successes in either an "auto" mode that reviews the entire clip or "manual" that allows stepping to the next event each
time the motion event occurs in the target area.

5. Systems Settings and Control Functions. This password protected function of the System shall offer password protected access to the operation and control functions of the System. The system shall be capable of operating in the following manner as set up by the user:
   a. General System Functions include initial the main monitoring display, output display, and time-date-name stamps for the camera identification on each video stream. Activation of the auto-recovery circuit, manual restart, or automatic shutdown shall be included. System name and all software version information will be identified. Choice of creation of an event log to track major activities of the system shall be available for recording in the system root directory or other protected location.
   b. Camera Functions shall allow control and setup of each camera for:
      1) The system shall offer a normal 24-hour recording schedule for a 7-day week determined by the method of recording trigger desired to include: Normal and uninterrupted recording, recording due to sensor input triggers, face activated recording, motion activated recording, recording as a result of a concurrent detected motion and alarm sensor input, and simple display without recording. An alternate "holiday" schedule shall also be available.
      2) Activation of each individual camera as connected.
      3) Identification of each camera for display on the system as well as to be available to remote users selecting a camera. Extended Camera Information available shall include server name, camera name, location information contact information, and alert e-mail address.
      4) Show or hide the video stream on the main system display video output stream and changing to full screen mode and audible alert when recording is activated by motion or alarm trigger.
      5) Identification of controllable PTZ camera brand for control through the system and selecting the camera communications parameters.
      6) Resolution, recording method and control of compression quality.
      7) Selection of imbedding character information in the image.
      8) Control of display and recording speed of each individual camera.
      9) Identification of the source of any audio to be imbedded in the video.
     10) Use of pre-and-post recording in motion and alarm events.
   c. Motion and Display Control Functions shall include individual camera setup and control as display and recording on the system for:
      1) Appearance of brightness, contrast, color saturation and color hue to help improve the video camera image as required.
      2) Control of the areas of the camera view where motion is to be detected and recording activated. This shall include up to 10 active zones within the camera view capable of being drawn on the screen to help eliminate unintended motion recording and sensitivity settings for speed of motion or size of moving object within the video frames.
      3) System shall allow testing of motion recording before finalizing.
      4) Selection of relay output and delay timing to ensure a profound event for transmitting a closed-contact signal to a device or alarm panel.
   d. Network Connection Functions shall include:
1) Control of access to the System by a remote user shall be able to be activated or disabled.
2) Transmission of video streams shall be controllable to improve throughput or improve frame resolution as desired.
3) Use of notification to a remote monitoring system location by network connection IP addresses or by telephone dial-up call. Remote location, with the Remote Monitoring Software in operation shall be notified should an activated camera create an output alarm. The remote location screen display shall switch to the alarmed camera and sound an audible tone to gain attention.
4) Each camera shall allow selection of an hourly schedule to be set for automatic alarm notification during a repeating week.

e. Input Sensor Triggering Setup and Operation shall include:
   1) Activation of an accessory input/output port connection to trigger recording and outbound alarm notification with delay verification.
      Identification of the device, high or low voltage sensing for the trigger and the camera associated with the alarm event shall be controllable.
   2) System shall allow testing of alarm input triggering before finalizing.

f. User Authentication and Multi-Level Passwords. Functions shall include:
   1) Entering and administering the addition or deletion of user authorization information consisting of a "account" or username and password to be used when seeking access to password protected areas of the System.
   2) Areas of individual control shall include access to settings menu, ability to gain remote access, ability to access search functions, control the PTZ functions of a camera, alter the video storage file system, administer backup operations, and authorize exit or shutdown of the system.
   3) System shall not acknowledge remote connection to the application should username or password not be valid.
   4) All attempts for password access shall be logged in the Event Log whether successful or denied.

6. Remote Server Access Software utilities with password protected, encrypted access to the camera server application via dial-up phone connection, Ethernet LAN or WAN. Remote Access Software provided with the digital surveillance system will not be restricted from being copied or freely distributed and can be operated on a compatible PC with a minimum configuration. Multiple remote locations shall be able to be concurrently connected to one server. Functions shall include:
   a. Phonebook function to enter and recall network addresses or dial-up phone numbers identified by a user-created keyword.
   b. Valid username and password shall be required to access any server and perform functions as authorized in the multi-level setup.
   c. With appropriate password authorization, remote users shall be able to display multiple streams of live video, record these streams on their local computer, access and play back recorded video on the server, control PTZ cameras, trigger up to four closed contact relay devices at the server location, obtain extended information on any camera, control the transmission frame rate and resolution, and restart the server remotely.
   d. Duplex audio (talking and listening) from both the server and remote access PC shall be capable of creating an "intercom" function in real time. Both systems
require PC microphone and speakers and is most successful using network communications.
e. An authorized remote user shall be able to modify most of the server settings. Exceptions are password authorization and motion detection setup.
f. The remote monitoring software shall use the same search program as in used on the server and allow access to recorded video and video with audio.

7. Multi-Server Remote Access Software shall be capable of concurrently accessing individual cameras from multiple, networked servers during one remote session and displaying those cameras on a multiplexed screen of up to 16 views. Multi-Server Remote Access sessions shall be capable of being created as templates, stored in a library of templates, and individually recalled through the use of a Multi-Server Remote Template Manager.

8. Archiving and Archive Viewing Software operating on demand or on a scheduled basis to compress and transfer stored video to an archived medium as a form of backup with a viewing utility to play back archived files by date and time stamp. The Video Archiving Software provided with the digital surveillance system will not be restricted from being copied or freely distributed and can be operated on a compatible PC of minimum configuration.

9. Authentication Utility, commonly called watermarking, shall allow a single video image saved as a single *.jpg frame or recovered from an archived video stream, to be authenticated as the original image with no changes since the original recording or to be identified as an image not matching the characteristics of the original image and assumed to be digitally altered or corrupted.

10. Cash Control and Reporting Software used with an optional text and data collection devices shall allow recording and storage of transaction or data information.

11. The Transaction Verification software application shall be fully integrated with the System to allow identification of transactions and recall the video clips recorded by identified cameras when the transaction occurred directly from the transaction verification program.

12. Required Accessories:
   a. 3 Processor display (PC, monitor) shall be required with a minimum color display of 1024x768. A minimum size is 32" although 42" is recommended. Any PC-compatible screen, Plug-and-Play monitor is acceptable.

E. Camera Server Operating Standards.
   1. The system shall be compatible with Windows 7, 8, 10 for monitoring and control and make use of MS-Windows utilities for operation and setup.
   2. It shall be capable operating as a client on Windows NT and Linux/Unix networks allowing remote access over customer computer networks.
   3. Remote access software shall be compatible with Win2000 up to Win10.

F. The Digital Surveillance System shall accommodate the following additional capabilities not required for basic operations:
   1. Multi-Server Remote Software for networked monitoring center customers supporting multiple server sites. This is an enhanced capability over the single-server remote access software that is provided as standard with the DSS systems.
   2. Pan/Tilt/Zoom Interface Controller required to connect specific brands of automated cameras capable of external motion and image control.
   3. I/O Relay Panel for receiving alarms from other devices or outputting alarms to
external alarm panels.
4. Proximity Access Modules, microchip proximity tags, cards or badges, and electrically activated door locks to support a safe and controlled-access environment.
5. Video Text Insertor device to combine register transaction data with the video viewed from a surveillance camera capable of also streaming data to a register transaction analysis application.
6. Wireless LAN Remote Connect capable of allowing any authorized user to activate the Remote Connect software from a wireless LAN enabled PC.
7. Communication connections for remote connectivity.

2.3 ACCESS CONTROL AND MANAGEMENT SYSTEM

A. System: Access Control System

B. System Requirements:
1. All devices required to complete the installation may not be described but shall be provided as if specifically called for within the Specification. It is the responsibility of the Contractor to provide a complete working system.
2. All system components shall be approved and certified for the function they will perform.
3. The system shall be of an open architecture design and shall support industry standard databases such as Microsoft SQL Server 2000/2005, MSDE or SQL Server 2005 Express and above.
4. A system server for enterprise wide database services, system programming, system monitoring, administrative services, report and proximity card generation.
5. A workstation computer shall provide interfacing and control of the local, site specific, Access/Security System.
6. The System shall be of a distributed database design, using intelligent microprocessor panels, to make smart decisions at the door.
7. The system shall be capable of utilizing a true client server network configured to support the system database service, all panel services and user interfaces optimizing the users’ options for system programming, event monitoring and record keeping.
8. The database service shall be ODBC compliant allowing the system to access an existing compatible ODBC compliant database as the system data source. A single system database shall maintain both credential-holder’s records as well as access system information and programming parameters.

C. Security Terminal Cabinets (STC):
1. The STC shall be a metal cabinet suitable for wall mounting.
2. The following components shall be mounted in the STC:
   a. Site Controller, Alarm Interfacing Panels.
   b. Terminal Strips. Double row barrier terminal strips.
   c. Power Supplies and Batteries
   d. Tamper switch.
   e. Other equipment which is required to provide a functional, working system.
   f. The door shall be protected by an anti-tamper device in such a way that a tamper alarm shall be generated if any portion of any door moves more than one quarter of an inch from its closed position. This alarm shall be sent to the Computer.
D. Power Supply Systems
   1. The Access Control Systems shall be fed from the UPS system power at 220/240 volt AC.
   2. Each Security Remote Control Panel shall have sealed, no-maintenance, rechargeable batteries.
      a. Sufficient power shall be included to allow the RCP to operate a minimum of 8 hours when loaded to its maximum configuration and capacities.
      b. Power back-up shall be of such size and capacity that 8 hours can be increased to a minimum of 24 hours.
      c. The batteries shall be enclosed in the RCP or in a Security Terminal Cabinet.
      d. An alarm with descriptive message shall be generated at the Computer whenever a RCP loses AC power and is operating on battery power.
      e. An alarm with descriptive message shall be generated at the Computer whenever a RCP loses back-up battery power.

E. Life Safety
   1. Card access system shall be connected to the fire alarm system by the Security Contractor.
   2. All electric doors in the pathway of building egress shall release as required by life safety code.

F. Access Control Server: Provide computer operating latest generation system supported by manufacturer, with more than recommended specification with card printer, capture card, camera.

G. Access Control - Primary Security Work Stations

H. Software Capacities:
   1. Software shall be existing, industry accepted, and of a type widely used in commercial systems. Operating system shall be multi-user/multi-tasking capable of operating in a non-proprietary CPU. The application software, substantially as offered, shall be written in a high level, industry standard programming language. The system shall be modular in nature, allowing the system capacities to be easily expanded without requiring major changes to the system operation and maintaining all defined system data as well as historical information.
   2. All System functions shall be accessible via point and click mouse control. Systems requiring command string control or complex syntax are not acceptable. The system software shall include the following features and be configurable for a minimum:
      a. 50,000/120,000 option credential capacity (at the ACP).
      b. Unlimited credential records (at the Database).
      c. 256 user-definable time schedules per loop/site.
      d. Unlimited programmable holidays.
      e. Unique holiday types.
      f. At least 1500 Access Groups.
      g. At least 10,000 Event log-buffer (at the ACP) for disconnect transactional storage.
      h. Customizable Operator Privileges - limit site, commands, and viewing rights.
i. Primary and Auxiliary door outputs for each defined reader.

j. Dedicated Door Contact and Request to Exit (REX) inputs for each defined reader.

k. Global Anti-Passback.

l. Door Groups.

m. Door Interlocking (Mantrap).

n. Remote Door Control.

o. Scheduled Unlock, with Valid Unlock on "day of" option.

p. Scheduleable PIN Required option.

q. Automatic Active/Expire Dates for Credentials.

r. Maximum "number of uses" settings per credential.

s. Americans with Disabilities Act (ADA) compliance in door and access operation.

t. Serial or Ethernet interface with CCTV matrix switchers or NVR units.

u. Input/Output linking with Boolean (AND/OR) logic.

v. Routable Alarm events.

w. User-selectable LED behavior.

x. Traced Cards.

y. Badge Print Tracking.

z. Setup Wizards.

aa. Online Help.

bb. Dynamic Device Status Screen.

c. Loop Diagnostic Software Tools.

d. User-Select Mandatory Fields.

e. Extensive Reporting using an Activity Matrix.


gg. ODBC Data Import/Export.

hh. Event Log Output.

ii. Data Audit Trail.

jj. Video Verification.

I. Software Operation:

1. The system shall provide a top down configuration methodology. Top down programming shall allow the system operator to configure the system software and hardware configurations in a logical flowing method. The system shall allow the operator to start at the highest configuration level of the system and then move down through the lower configuration levels without having to move back and forth between a variety of menus.

2. The system shall utilize dynamic icons. The dynamic icons shall change appearance, in both color and icon display based upon the status of the associated object. This appearance change shall occur in real time and shall not require the system operator to perform a screen refresh or exit the current screen.

3. Dynamic icons shall be provided to represent:

   a. Door lock control.
   b. Cameras and domes.
   c. Alarm input.
   d. Output control relay.
   e. Manual operator actions.
4. For intelligent field panels hard wired to the host computer, the dynamic icons shall reflect the true state of the device represented by the icon. If an operator issues a command to unlock a door, and the field panel which controls that door is not in communication with the host computer, the icon shall not change state or appearance.

5. Where certain data fields within data screens may contain the same information, the system shall provide the ability to define default settings for these data entry fields including "drop-down" select lists. The operator shall be able to change the default setting without impacting objects that have already been defined.

6. Open Database Connectivity: The Security Management Control System shall utilize a database engine which is Open Database Connectivity (ODBC) compliant. The system shall allow the ability to perform ODBC writes to the system database to import personnel data directly into that database.

7. It shall be possible to use third party report tools, such as Crystal Reports to generate reports not already provided by the Security Management Control Systems, such as statistical or graphical reports of system activity.

8. ODBC password protection: Database level Username and Password protection shall be provided for ODBC users. ODBC users will be required to supply a Username and Password when they connect to the database. Usernames and passwords shall be configured via the user configuration functionality currently available in the Administration utility.

J. Hardware Definitions:

1. Menu Configuration: The System software shall allow for the configuration and programming of the access control modules through the use of simple menu commands. The menu commands may be executed by keystroke and mouse point/click control.

2. Memory: The allocation of memory, between cardholder records and historical event buffering, within each access control modules shall be separated. Transactions shall not overwrite programmed data but rather maintain an allocated 10,000 event buffer.

3. Clusters/Sites: The system software shall allow the configuration for up to 255 Clusters each maintaining up to 254 intelligent field panels with ability to configure and maintain all Clusters simultaneously.

4. Database Updates: The system software shall download/upload information to/from the System Server automatically while the controller is in communication with the host CPU.

5. Hardware Components: The system shall maintain hot-swappable components for easy repair replace procedures. These components shall include Central Processor, Digital Input/Output board, and Dual-Port Interfaces.

6. Expansion: System expansion shall be modular. Additional modules required for incremental system expansion shall be available in two (2), eight (8) and sixteen (16) door configurations to allow for maximum installation flexibility and optimum cost.

K. Time Specifications:

1. Holidays: The system software shall allow unlimited holidays. Holidays shall be considered as additional days of the week and shall have different user programmable parameters from the normal designations for that day. The system shall provide the ability to designate nine (9) types of holidays, allowing certain segments of the system to be under holiday control, while other segments of the system are under normal time
controls. The system shall allow the holiday to be addressed within the system by the user defined name assigned to that holiday, i.e. New Year's Day, can be addressed as New Year's Day.

2. Configuration: Each time specification shall be comprised of user defined time segments. Each time segment shall be day(s) of the week, to include holidays, and a starting time and an ending time. The system shall provide point, click, and drag functionality as well as copying tools, for easy system configuration.

L. Time Zone Management:
   1. General: The system shall allow the end user to configure the host server, operator workstations, and field hardware devices, such as access control panels, clearances, elevators, some groups and reports to be in different time zones. A time zone is a “time zone” such as Eastern Standard Time and does not indicate a time specification.
   2. Operating System Name: The system shall support all time zones supported by the operating system. When defining a time zone to be used by the system, the system shall be provided with a drop down listing of all time zones defined by the operating system. The operator shall be able to select the appropriate time zone from this listing.
   3. Event Monitoring Workstations: The activation date/time and the host-received date/time of activity shall display with respect to the time zone where the operator workstation is located.
   4. Adjust for Daylight Savings Time: For each specified Time Zone, the system shall supply a non-editable field indicating whether or not the specified Time Zone adjusts for daylight savings time.

M. Alarm Events
   1. System Usage: Events shall be used throughout the system to allow the system to react to system activity. For instance an event may be activated based upon an alarm point going into an alarm state. Events shall merge the links to actions, annunciation, communications port failure and timed activation capabilities into one component. An event shall perform multiple functions determined by the actions the user associates with it.
   2. Event Priority: The system shall provide 10,000 priority levels. The system shall allow the operator to choose an individual priority.
   3. Configuration: The system shall allow an event to be configured to:
      a. Require or not require operator acknowledgment.
      b. Not be cleared unless a log message is entered by the system operator responding to the event.
      c. Display or not display the event activation.
      d. Require the point(s) causing the event activation to reset before the operator may acknowledge the event.
      e. Display a user defined text message (at least 80 characters) upon event activation.
      f. Display a user defined text message (at least 80 characters) when event is deactivated.
      g. Be associated to a map so the map opens automatically on the Monitoring Station when that event activates.
      h. Configure an event so that if it activates and is unacknowledged for a specified
period of time, a second event is activated
i. Allow the user to associate and audio wave file with an event.

4. Event Instructions: The system shall allow the user to define event instructions that shall be displayed to the system operator when responding to an event activation. There shall be no limit to the amount of text that may be included in the event instructions.

5. Action List: The system shall allow an event (input, valid access, etc.) or trigger to be configured to cause other system actions to occur. These system actions shall include:
a. Lock/Unlock door(s) and/or door group(s).
b. Momentary unlock of door(s) and/or door group(s).
c. Secure door(s) and/or door group(s).
d. Incremental counting results.
e. Decrementing counting results.
f. Limit counting results.
g. Alarm/disarm event(s) and/or I/O group(s).
h. Alarm/disarm alarm input(s) and/or input group(s).
i. Activate/deactivate output control relay(s) and/or output control relay group(s).
j. Momentary activate output control relay(s) and/or output control relay group(s).
k. Activate CCTV action.
l. Automatic display of an associated map on a Monitoring Station.
m. I/O Group set triggering.
n. Activate Discovery NVR (or approved equal) action.
o. Activate Discovery NVR (or approved equal) pop-up.
p. Activate PC audible alert.

6. Crisis Mode: The system shall control, on an action by action basis, dynamic access, input and output changes. Thus when initiating a Crisis Mode on a site, inputs and outputs can react accordingly and access privileges (system-wide) will be modified to an alternate setting.

7. Time Control: It shall be possible to control via a user defined time schedule the period during which an event shall be armed and therefore capable of being activated by other system actions.

8. Graphic Map Display: The system shall allow a graphic map display to be linked to an event. This graphic map shall be available to the system operator to display when responding to the event activation. Graphical maps shall be centralized in the network on a shared disk and be available for display on all operator workstations.

9. Automatic Graphic Map Display: The system shall allow for the automatic display of a graphic map-linked to an event. This graphic map shall be available to the system operator to display when responding to the event activation. At the Monitoring Station, when an event is configured to automatically display a map, a map will pop up each time the event is activated. The map will disappear when the event is acknowledged. Graphical maps shall be centralized in the network on a shared disk and be available for display on all operator workstations.

N. Door Definitions:
1. Door Names: Each door shall be addressed within the system by a unique hard-coded name relevant to the location within the controller position and a "user-friendly" definable name for easy recognition
2. Reader Operation: The system shall allow a reader to be configured to operate using the following functions:
   a. Readers shall read cards while the door is in the open position.
   b. Door lock shall automatically lock upon the door being opened.
   c. Door lock may be configured to lock upon the door being closed.
   d. Separate timers for the operation of the door lock and the software shunting of the door position status alarm point. The shunting of the door contact following the presentation of a valid access card or activation of the request to exit device shall be accomplished by software control.
   e. Door Alarms: The system shall allow each door to be configured to cause a variety of events to occur based upon activity at that door.
   f. Ingress areas shall be disarmed based on Valid Access at the door by a software mechanism without the use of an auxiliary relay.
   g. Reader shall allow for association with Video Verification module.
   h. Reader shall allow for automatic schedule based on time schedules and a provision for refraining from unlock based on no Valid Card for that day (i.e. Snow Day rule).
   i. Auxiliary relay may be associated to react based on triggerable door events.
   j. Alarm associations may be made based on the following door actions.
      1) Door Forced Open.
      2) Door Open too long.
      3) Invalid Attempt.
      4) Passback Violation.

3. Output Activation: The system shall allow each reader to be configured to cause an output to activate based on activity at that door.

4. PIN Required During Time Specification: The system shall allow for a time specification to be configured and associated to a door that will require a valid PIN entry for access during the specified time spec after a card access (unless a manual action or event has disabled PIN).

5. Report View: The system shall allow reports to be generated directly from the reader properties’ screen without having to search sub-set report menus. The system shall also allow for a right-click function to run reports from a Hardware Tree or event transaction of the door.

O. Input/Alarm Configuration:
   1. Input/Alarm point name: Each alarm point shall be addressed within the system by a unique hard-coded name relevant to the location within the controller position and a “user-friendly” definable name for easy recognition.
   2. Input/Alarm point configuration: The system shall accept as an alarm input: supervised alarm inputs, unsupervised alarm inputs and dedicated alarm points such as device tamper alarms and controller AC power failure.
   3. Input/Alarm arming: The system shall have the ability of monitoring input points in eight (8) states for triggering conditions:
      a. Active: Monitored activation of input.
      b. Alarm: Monitored activation of input while in an armed state.
      c. Armed: Device placed in armed state either by alarm input or arming schedule.
      d. Disarmed: Device placed in disarmed state either by event trigger or disarm schedule.
e. Nothing: No triggering conditions for set input.
f. On: Monitored input that has been activated but not armed.
g. Trouble: Monitored input maintaining supervision that cannot validate the correct resistance value (due to cut or short).
h. Trouble or Alarm: Monitored input is that maintains either a trouble or alarm condition.

4. Report View: The system shall allow reports to be generated directly from the input properties' screen without having to search sub-set report menus. The system shall also allow for a right-click function to run reports from a Hardware Tree or event transaction of the input.

P. Output Control Relay:
1. Output Control Relay Name: Each output point shall be addressed within the system by a unique hard-coded name relevant to the location within the controller position and a "user-friendly" definable name for easy recognition.
2. Activation Control: Output control relays shall be defined as maintained or momentary. Maintained output control relays shall be configured to be activated/deactivated based upon a user defined time schedule, linked to a system event or operator command. Momentary output control relays shall have a user-defined pulse time (defined in 1 second increments). It shall be possible to use the momentary output control relays for the momentary control of devices other than door locking hardware. Output control shall also have the inherent ability to utilize Boolean logic including ability to act upon logic, limiting, and counting triggers.
3. Virtual Outputs: There shall be the ability to trigger software-based outputs that can later be associated as future triggering inputs for advanced logical schemas.
4. Report View: The system shall allow reports to be generated directly from the output properties' screen without having to search sub-set report menus. The system shall also allow for a right-click function to run reports from a Hardware Tree or event transaction of the input.

Q. Operators/Users:
1. Password: The system software shall be capable of identifying an unlimited number of system operators. Passwords shall be hidden from the Software GUI
2. Operator Name: Each operator authorized to operate any portion of the system shall be addressed within the system by a unique user defined name. The operator name will be used throughout the system to identify commands and functions that the operator has executed as part of an audit trail.
3. Operator Activity: All commands issued by a system operator while monitoring system activity including locking/unlocking doors, event acknowledgment, etc. shall be stored in the historical archive for later recall. The report command shall include the operator name, time and date the command was issued and the command issued by the operator.
4. Report View: The system shall allow reports to be generated directly from the operator properties' screen without having to search sub-set report menus.

R. Operator Privileges:
1. Privilege Control: Each operator shall be assigned an operator privilege matrix. Operator privilege matrices define the individual commands within the system which the operator is authorized to execute.
2. Administrative/Master Privilege Construction: When selecting the Master Operator privilege option within the system, the operator shall be given access to assign/modify the Operator privileges along with select Workstation options.

3. Online-Actions Privilege Control Construction: Each operator may be configured to have access to perform online (software generated) actions with Doors/Readers, Inputs, Outputs, I/O Groups, Elevators, and Card Commands to include:
   a. Unlock: Unlocks the door/reader until a subsequent command, trigger, or schedule relocks the device.
   b. Lock: Locks the door/reader until a subsequent command, trigger, valid access, or schedule unlocks the device.
   c. Pulse: Performs a momentary (pre-configured duration) unlock of the door/reader.
   d. Enable (Reader): Enables the reader after a disable command.
   e. Disable (Reader): Disables the reader (typically for service operation).
   f. Relay 2 On (Reader): Fires (Turns On) the auxiliary relay of the door/reader port.
   g. Relay 2 Off (Reader): Releases (Turns Off) the auxiliary relay of the door/reader port.
   h. Shunt (Input): Masks reporting of the input device until a subsequent command, trigger or schedule unshunts the device.
   i. Unshunt (Input): Enables reporting of the input device until a subsequent command, trigger or schedule shunts the device.
   j. Service Mode (Input): Disables Input actions for service operations.
   k. Restore (Input): Enables input actions after Service Mode is selected.
   l. Arm (Input): Manually places input into an armed state until a subsequent command, trigger, valid access or schedule disarms the device.
   m. Disarm (Input): Manually places input into a disarmed state until a subsequent command, trigger, or schedule arms the device.

S. Credential Record Definitions:
1. User Defined Labels: The system shall allow a privileged system operator to specify field name, field type, field restrictions and whether or not a field is mandatory and/or selectable. The system shall provide the operator the ability to view the credential record layout, including the new labels, before the changes are put into use.

2. Personnel Records: Personnel records shall be constructed to contain personnel data and user defined fields. The personnel data shall consist of a minimum of the following:
   a. Credential-holder name.
   b. Encoded card number.
   c. Employee ID number (system defined, Primary Key).
   d. Last Access.
   e. Card Technology.
   f. Personal Identification Number (PIN) code.
   g. Facility number.
   h. Activation date and time.
   i. Expiration date and time.
   j. 21 user defined fields.
   k. Department.

m. PIN Exempt.

n. Passback Exempt.

o. Number of Uses.

p. Stored image of the person.

q. Stored signature of the person.

r. Store biometric fingerprint identification of the person.

s. Identification badge layout assigned to the person.

t. Date last identification badge was printed.

3. Mandatory Data Fields: The system software shall provide a means whereby the master operator may define certain user-defined fields in the personnel record as being mandatory. Personnel performing data entry on the card holder record shall be required by the system to enter information in all field marked by the system administrator as mandatory.

4. Select List Fields: The system software shall provide a means whereby the system administrator may define certain user-defined fields in the personnel record as choice list fields. The system administrator shall be able to define the choice list and the values to be included in the choice list. The operator, when performing data entry, shall be able to choose one of the values defined in the choice list.

5. Card Record Import/export: The system software shall provide means for bulk loading and bulk editing of card records through the use of a data file generated from another source. The external file shall be an ODBC file source. The system shall also provide the ability to generate the same format file of existing card records, allowing the information in the system to be exported to other computers and applications. The system shall allow the user to select the card records that shall be included in the export file.

6. Query Capabilities: The system shall provide a card holder selection list, allowing the system operator to choose individual cardholder records from the selection list. The selection list shall provide a quick sorting display of all cardholder records and advanced SQL query tools including an SQL query builder.

7. Report View: The system shall allow reports to be generated directly from the cardholder properties’ screen without having to search sub-set report menus. The system shall also allow for a right-click function to run reports from the event transaction of a cardholder.

T. Automated Personnel Data Import:

1. Overview: The system shall provide a means to import personnel information from an external ODBC database other than import from a flat file. Additionally, the import shall execute in the background periodically to avoid the need to run the Administration application each time personnel data is to be imported. The import procedure shall also perform the necessary validity checking to prevent corruption of the system personnel table.

2. Automated Import Name: Each Automated import shall be user defined name. The profile shall be saved with an import schema on the hard drive of the system workstation.

3. Import Options: The system shall allow the user to specify how the records are retrieved from the external database during the automated process and the amount of detail the import activity log will display after an automated import is run.
4. **Data Source(s):** The system shall allow the user to select from a list of external databases. It shall allow the user to enter a user ID and password if one is required by the external database.

U. **Reports:**

1. **Data Storage:** All programmed and transactional history is automatically stored to the database for later recall. Information written to the database shall be immediately available for report generation.
2. **System Function:** The system software shall be able to generate reports without affecting the real-time operation of the system.
3. **Media:** Reports shall be generated from the database and generated to the operator's screen, hard disk, floppy disk or printer(s).
4. **Search Criteria:** The database shall be structured such that the operator shall determine the search parameters based on variables available on the individual report matrix. Systems requiring the user to type complicated search strings are not acceptable.
5. **Report Types:** Programmed data reports shall be available for Database Configuration and Historical Activity.
6. **Database Configuration Reports:** The system shall be capable of producing reports of database configuration information. These database configuration reports shall include hardware and software configuration, group, time zone, activity and audit log reports.
7. **Report Selection:** Depending upon the type of report being generated by the system operator, the system shall provide a listing of previously defined reports. The operator shall be able to pick an existing report, modify an existing report or generate a new report.
8. **System Defined Reports:** The system shall contain predefined reports that shall report the database configuration for area, holiday, time specifications, time zones, elevator, event, all groups, control outputs and authorized card holders.

V. **User Status "Who's-In" Report:** The "Who's-In" report shall provide a listing of all personnel that the system has determined to be in a user-specified area. The "Who's-In" report can be used in emergency evacuation situations, to determine if personnel are in the building, and where they are in the building. The "Who's-In" report can be initiated by an event or run as a report by a system operator that can be automatically refreshed on the screen to keep current as personnel exit the area.

W. **Audit Trail:** The system shall provide an audit trail function that is intended to record all permanent changes in data configured by system operators. The audit trail shall record permanent changes made to the configuration database by manual operator data entry.

X. **Help Screens:** On line help: The system software shall have on line help available at any point requiring operator input. The help screen shall be accessible from a pull down menu. This help screen shall contain information that shall allow the operator to enter correct data without consulting a manual.

Y. **Activity Monitoring:**

1. **General Display Features:** The activity monitoring screen shall include the event, date/time display, user, active events, events require acknowledgement and loop/site
2. Event Audible Annunciation: Event audible annunciation refers to the beeping behavior of the operator workstation when there is at least one active and unacknowledged event. The operator workstation shall beep continuously as long as there is at least one active and unacknowledged event. The beeping shall continue until the operator acknowledges all such events or uses the "Silence" button to silence all audible for all such events.

3. Pop-Up Events:
   a. When an event needing acknowledgment becomes active, the alarm monitoring screen shall be displayed on all operator workstations currently logged in designated to receive such a priority alarm.
   b. If the System Galaxy program has been shrunk to an icon, the alarm monitoring program shall pop open and be displayed on the operator workstation as the top-most window.
   c. If the event monitoring program is behind other tabs, the alarm monitoring program shall be pop forward and displayed on the operator workstation as the top-most tab.

4. Scrolling Display: The system shall contain a scrolling display of system activity. The system shall provide a scroll bar to allow the system operator to move up/down among the event messages on the screen. The system operator shall be able to scroll back through the previous 1000 transactions of system activity.

5. Display Types: The system shall provide an activity-monitoring screen which shall operate in multiple modes. The first mode shall allow the system operator to view all system activity, including scheduled actions, card accesses events, etc. These events shall be displayed in chronological order. The second mode shall display only those system events, which require operator action. The system shall allow the operator to view events in order based upon alarm priority or time of activation. A third mode shall allow for a split screen (on one or multiple monitors) providing the ability to display both General Events and the Alarm Events.

6. Event Instructions: The operator shall also have the ability to view additional details of the event through the use of a single keystroke. By clicking on the event item with the mouse, the operator shall be presented with alarm response instructions that have been programmed into the system.

7. Message Color: The system shall allow the operator to select the color that shall be used in displaying event messages on the operator workstation. The operator shall be able to choose from any of fourteen (14) colors. The event message color shall be based upon event message type and event priority.

Z. Graphics:
   1. Graphics File Format: The system shall allow graphics and floor plans to be linked to points and events within the system. These graphics and floor plans shall be configured in a .BMP or .DXF format to allow for the importation of existing drawings.
   2. Programming: The system software shall, through the use of a mouse, allow for placement of device icons on each graphic/ floor plan. The device icons which may be placed on the graphic/ floor plan shall include alarm inputs, output control points, doors and any other graphics.
   3. Operation: Upon activation of a selected event, the operator shall, by the use of a
single keystroke, view the associated graphic/floor plan on the monitor. The operator shall use the mouse to click on any of the icons on the graphic and issue a command associated with the icon.

4. Storage: The graphics feature shall take advantage of the Client/Server system configuration, with all graphics being created/stored on a shared disk in the network. These graphics shall be available to all authorized Operator workstations.

AA. Controllers connected to the Security Management Control System shall utilize Flash ROM for storage of the operating program used to run the controller. It shall be possible to download the controller's operating program directly from the Security Management Control System. The system shall not require a technician to physically change the ROMs on the controller in order to change the controller's operating system.

1. Operating Program Distribution: The manufacturer of the Security Management Control System shall offer a variety of methods for distributing the flash program for the controllers. This distribution method shall include but not limited to: floppy disk, CD-ROM, and the manufacturer's web site. The controller's flash program shall be loaded on the SG Comm service and then downloaded to the controllers over the communication lines connecting the host system to the controllers.

2. System Operation:
   a. The Security Management Control System shall provide the system administrator with a status display indicating the revision level of flash program currently running in each controller.
   b. The system shall provide controls allowing a privileged system operator to issue a command to download the flash program to the controllers. The operator shall be able to select which controllers shall receive the flash download and the revision level of the flash program the controllers shall receive.
   c. If a controller is not communicating with the host, or is a dial-up panel to which communications cannot be established, the download of the operating program shall be delayed until communications is restored or the download request is canceled by a system operator.
   d. The flash program may be downloaded to a controller but not burned into memory allowing for an opportune time to reset a controller without causing system inconvenience.

3. Controller Operation:
   a. While the operating program is being downloaded from the host computer, the controller shall continue to operate as normal. The flash program being downloaded shall be stored by the controller in temporary memory until the entire operating program is received. When the entire operating program is received by the controller, the controller shall provide the operator the option of when to restart. The controller shall delete the previous version of the operating program and begin running the new operating program.
   b. If the controller has insufficient space to receive the new operating program, or the complete new operating program is not received, the controller shall report this to the host computer as an invalid flash load.

BB. The Access Control Panel: shall be an intelligent, modular controller designed to integrate various event management applications on one controller.

1. Primary Controller: The Primary Controller is the controller responsible for
up/downstream communications with the PC/Network. The Primary Controller consists of three major subsystems, software services, hardware and expansion interfaces.

a. Software Services: The software services are a set of common functions to perform system configuration, generic system event handling and communications between the controller and a host or other controllers.

b. Hardware:
   1) Ethernet Port: The Controller shall support 10/100BaseT Ethernet Communication. The interface to the Ethernet services shall be through a standard RJ-45 jack connector native to the controller. Provide as many as required for full system integration.
   2) Inputs/outputs: The controller shall have three (3) on-board inputs. The inputs are reserved for tamper, power fail, and low battery.
   3) Serviceable Hot-Swap Modules: The Controller shall allow for "Hot-Swap" serviceability. This allows for communications and door modules to be interchanged without a controller power-down.
   4) Indicators: There shall be LEDs indicating the status of the received and transmitted data for the onboard communications ports, with active data turning on the LED. These LEDs shall be hardware controlled.
   5) Ports: There shall be multiple ports provided on-board for external read heads, input/output boards. The number of actual ports varies according to the controller configuration.

CC. Access Control Panel (ACP) Software Features and Settings:
   1. The ACP shall provide for configuration, status and event reporting using the embedded system services.
   2. An access control system selectively allows certain people to enter an area. The ACP shall allow access to identified individuals, shall control entry by time, and shall record entries. The ACP shall also allow a host to control access, or allow an access cycle to be controlled by a request-to-exit input.
   3. Access Control Services:
      a. Door Access Control: The Host shall allow the ACP to handle door configuration and control.
      b. Door Configuration: The door configuration defines the behavior of a door and includes the following parameters:
         1) Inbound and Outbound Access Reader(s) - which readers are monitored at this door.
         2) Door Switch Monitor (DSM) - usually a simple switch that changes state when the door is opened or closed. The switch, if enabled, connects to a monitored input. If the DSM input becomes active while not shunted, it will generate a Door Forced Open alarm.
         3) Door Shunt Time - how long the DSM should be shunted after the door is opened for access. The configuration may also indicate whether the DSM shall remain shunted for the full shunt time, instead of clearing when the door closes. If the DSM remains active after the shunt time expires, it shall generate a Door Held Open event.
         4) Request to Exit (RTE) Input - an input whose activation triggers an access cycle that allows egress through a door. The RTE Input shall be
placed on the protected side of the door. The configuration may indicate whether the DSM shall be shunted as long as the RTE is active, and whether the DLR shall be enabled for an RTE access.

5) **Door Latch Relay (DLR)** - the output which controls the strike for the Door Unlock Time - the length of time, in seconds, that the DLR is energized during a valid access cycle. The DLR is normally energized for a valid access, and de-energized as soon as the door opens, but a Re-lock Delay may cause the DLR to be energized for a number of seconds after the door opens. Access grant decisions based on presented cards, RTE access based on RTE input activation, and host requests for momentary unlock of the door all cause the door to perform a valid access cycle.

6) **ADA Output** - an output may be configured to activate at 1 second after the door is unlocked for valid access, for a duration of 1 second when the door is being accessed by cardholders with an ADA flag in their personnel record.

7) **Expanded Shunt Time** - For certain cardholders, a longer shunt time may also be configured.

8) **Door Control** - The ACP shall allow door control from a host. The door mode may be set to lock, unlocked, momentarily unlocked, or access disabled modes. A momentary unlock request will start a valid access cycle process on the door.

9) **Door Status Reporting** - The ACP shall report door alarm status changes including door held open and door forced open.

10) **Door Event Configuration** - The ACP shall allow the configuration of Events that are activated by certain door events. The supported events shall include:
    a) Door held open causes Event.
    b) Door forced causes Event.
    c) All valid access causes Event.
    d) All invalid access causes Event.

4. **Door Groups** - The ACP shall allow the configuration of door groups by a host. Door groups may then be used in emergencies, or to group doors for common control.

5. **Reader Configuration** - The ACP shall allow reader configuration from a host. The reader configuration defines the behavior specific to a reader on a door and includes the following parameters:
   a. Default PIN Mode - If a card reader includes a keypad, it may be configured to require the cardholder to enter a Personal Identification Number (PIN), in addition to presenting a card, to gain access at a door. A Time Specification may be entered to control this mode on a time basis.
   b. Card formats - the card formats supported at this reader.
   c. Card Entry Through Keypad - If card readers include keypads, they may be configured to allow the cardholder to enter their card number through the keypad instead of by presenting a card.
   d. Exit Area - The area from which this reader exits. This parameter is not applicable for readers that are on an elevator.
   e. Entry Area - The area to which this reader enters. This parameter is not applicable for readers that are on an elevator.
6. Floor Groups: The ACP shall allow the configuration of floor groups. Floor groups are primarily used in elevator clearances.

7. Fingerprint Scanners: The ACP shall be interfaced to the fingerprint scanner through a Wiegand.

8. Input Services: The ACP shall allow the configuration and control of inputs connected to AMMs and inputs connected to the ACP and any logical input that may be maintained by the ACP.
   a. Input Control: The ACP shall allow the control of inputs including arming/disarming the input.
   b. Input Status Reporting: The ACP shall allow the retrieving of the current status of inputs and shall log changes in input status.
   c. Input Event Configuration: The ACP shall allow the configuration of input Events. These Events will include:
      1) Activation during a specified time specification causes Event.
      2) Activation outside a specified time specification causes Event.
      3) Supervision error causes Event.

9. Input Groups: The ACP shall allow the configuration of input groups. Input groups may be referenced by Events.

10. Output Services: The ACP shall allow the configuration and control of outputs connected to the ACP.
    a. Output Definition: The ACP shall allow the configuration of outputs. Output configuration controls the behavior of the Output and includes Enabled/Disabled and reversed outputs.
    b. Output Control: The ACP shall allow the control of outputs, including setting the current state to activated, deactivated, or momentarily activated.
    c. Output Groups: The ACP shall allow the configuration of output groups.

DD. The Diagnostic Web Server: The Diagnostic Web Server shall generate real-time operational and diagnostic information on a networked ACP to be viewed by a user from a standard web browser, such as internet explorer. This web server, residing on each ACP, shall answer requests from a standard web browser and shall generate and serve up HTML pages that indicate controller status and diagnostic information.

2.4 CCTV


2.5 READERS

A. Proximity cards and card readers, long range proximity card reader shall be manufactured by Manufacturer with 15 Years experience.

B. Readers: Manufacturer, Shall be manufactured by Manufacturer with 15 Years experience.

C. Barcode Readers: Shall be manufactured by Manufacturer with 15 Years experience.

D. Keypad Readers: shall be manufactured by Manufacturer with 15 Years experience.
E. Biometric Readers: Fingerprint biometric readers, shall be manufactured by Manufacturer with 15 Years experience.

F. Wireless Readers: shall be manufactured by Manufacturer with 15 Years experience.

G. Smart Readers: shall be manufactured by Manufacturer with 15 Years experience.

H. FIPS 201 Readers: Shall be manufactured by Manufacturer with 15 Years experience.

2.6 PRINTERS

A. Sublimation Printer: Shall be manufactured by Manufacturer with 15 Years experience.

PART 3 EXECUTION

3.1 INSPECTION AND PREPARATION WORK

A. This contractor shall examine the conditions under which the system installation is to be performed and notify the Owner's Representative and Consultant in writing of unsatisfactory conditions. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to provide a workmanlike installation.

B. Review areas of potential interference and resolve conflicts before proceeding with the work. Coordinate ceiling layout and wall layout and other work that penetrates or is supported throughout the space of the building. All work shall be flush and workmanlike in all finished areas.

3.2 INSTALLATION

A. Install materials and equipment in accordance with manufacturer's printed instructions to comply with governing regulations and industry standards applicable to the work and as shown on approved shop drawings.

B. Arrange and mount all equipment and materials in a manner acceptable to the consultant and Owner.

C. Installation shall conform to the basic guidelines.
   1. Use of approved wire, cable, raceways, wiring, devices, hangers, supports and fastening devices.
   2. Separation of high and low voltage wiring is required throughout the installation.
   3. All wiring shall be thoroughly tested for grounds and opens.

D. All power wiring shall be in metallic conduit. The maximum conduit fill shall not exceed 40% of rated capacity. Refer to NFPA 70-NEC for additional requirements.

E. Contractor shall employ a subcontractor as an approved elevator manufacturer to interface the Card Access System to elevators.

F. Cabling and Wire Requirements:
   1. Low voltage signal and/or control wiring shall run in separate conduit/raceway from
electric power cables. Cables for door locks are power cables. Provide separation from lighting fixtures and other electrical appurtenances. Provide electrical interference protection circuits as required to maintain the signal quality specified herein and required by system manufacturers.

2. The individual systems low voltage cabling shall use separate junction boxes and enclosures.

3. The minimum low voltage cabling for security, communications and safety systems shall be as required by the manufacturers without cost increases to owner for the full function intended. The systems cabling shall meet the requirements of NFPA 70/NEC Articles 725, 760 and 800 as applicable for each type of system specified.
   a. All dimensions and conditions shall be verified in the field. The Contractor shall notify the consultant of any discrepancies before proceeding with the work.
   b. Card reader cables shall be NFPA 70, Article 725 compliant.
   c. Electrified mortise and door strike power cabling shall be NFPA 70, Article 725 compliant.
   d. Touch sensor bar power cabling shall be NFPA 70, Article 725 compliant.
   e. Door control/door monitoring power cabling shall be NFPA 70, Article 725 compliant.
   f. Card Readers to Control Panel: maximum length shall not exceed 500 feet.
   g. Extended Reader Line Drivers: may be used between the Central Unit and the Remote Unit for a maximum length not to exceed 10,000 feet (3050 m). Cabling between the Central unit and the control panel shall be as specified for a reader, request to exit and a relay. Cabling between the Remote Unit shall be as specified for a reader, request to exit and a door strike.
   h. Alarm Point and Request to Exit Point to Control Panel: maximum length shall not exceed 500 feet (150 m).
   i. Relay to Device: maximum distance shall not exceed 1,000 feet (300 m).
   j. Refer to the riser diagram located on the Contract Drawings.

4. The minimum bend radius of all security, communication conduits provided under this project shall be 6 inches (150 mm). Provide and maintain pull strings/tapes/ropes in all conduits for future installation of additional cabling.

G. Junction Boxes, Enclosures/Cabinets, Equipment Racks:
   1. The junction and pull boxes shall be securely attached to the structural members of the building at locations accessible for servicing. Provide access doors at locations accessible for servicing. Provide access doors at locations where access is not readily available.
   2. The equipment enclosures shall be installed at approved locations and be typically ventilated as required to maintain the environmental conditions specified by the electronic equipment manufacturers.
   3. All junction boxes and pull boxes shall be labeled. The box label shall state the system and use of cabling. The labeling shall be made with markers which are indelible when and after in contact with water and oil. Labeling of junction boxes visible to inmates shall be approved by Architect/Engineer and Owner.
   4. Each box and enclosure shall contain a cabling and wiring log identifying all cabling accessible whether is connected or is passing by.

H. Grounding and Surge Protection:
   1. Provide single point grounding of the individual systems as recommended by IEEE
and system manufacturers. Provide all cabling, bonding and insulation materials as required. Provide surge protection and clamping for all circuits. Coordinate all grounding, surge protection and clamping circuit requirements with the system manufacturers.

2. Coordinate grounding requirements with other trades and contractors to preclude closing of ground loops via peripheral equipment supplied from different electrical power sources. Provide isolation transformers and other equipment as required.

3.3 PROGRAMMING

A. Complete system programming shall be provided by the installer and system manufacturer.
   1. Programming shall be accomplished by direct interface and review with the Owner and consultant.
   2. Programming shall continue until all interfaces, reports and system operation meet the requirements.
   3. Actual building CADD drawing shall be used as the graphical maps for the backgrounds of device location.

3.4 FIELD QUALITY CONTROL

A. A project manager shall be appointed during the course of the installation. This shall assure complete coordination and technical information when requested by other trades. This person shall be responsible for all quality control during installation, equipment set-up and testing. This individual shall have training to provide firsthand knowledge of the installation.

3.5 ADJUSTING, TESTING AND CLEANING

A. Contractor shall be required to perform complete testing and verification of the following:
   1. Card Reader maximum access time shall be 0.75 seconds under all system loads, i.e. regardless of number of cards presented simultaneously.
   2. Proper operation of electric door strikes, egress switching (where required), door position monitor switches and exit hardware.
   3. Proper operation of electro-magnetic locks and strikes, including full interface, control and override by the Card Access System.
   4. Proper operation of magnetic door switches.
   5. Proper operation of keyed EML bypass / override stations.
   6. Proper operation of the intercom system(s) and their door release pushbuttons.

3.6 MANUFACTURER'S FIELD SERVICES

A. Provide manufacturer's field services for the start-up, commissioning and training of this system.
   1. Include services of technician to supervise programming, adjustments, final connections, system testing and training Owner's personnel.

3.7 DEMONSTRATION

A. Provide system demonstration.
   1. Demonstrate normal and abnormal modes of operation and required response to each.
2. Provide system training.

3.8 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.

End Of Section 28 23 00