

**PGH INFRASTRUCTURE PROJECT
FELICIDAD SY
MULTI-SPECIALTY BUILDING**

Taft Ave., Ermita, Manila

**Technical Specifications
for
Fire Protection Systems**

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Infrastructure Project
FELICIDAD SY MULTI-SPECIALTY BUILDING
ERMITA, MANILA CITY

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1. Section 078413 - Penetration Firestopping
2. Section 210010 - Fire Protection General Provisions
3. Section 210051 - Common Work Results for Fire Suppression
4. Section 210513 - Motors, Starters, Control Centres & Wiring
5. Section 210529 - Hangers and Supports
6. Section 210548 - Vibration and Seismic Controls for Fire Suppression
Piping and Equipment
7. Section 210800 - Commissioning of Fire Suppression
8. Section 211226 - Fire Hose Cabinets
9. Section 211313 - Wet Pipe Fire Suppression Sprinkler
10. Section 211319 - Pre-action Sprinkler System
11. Section 212000 - Fire Extinguishers
12. Section 212200 - Clean Agent Fire Extinguishing System
13. Section 213113 - Electric-Drive, Centrifugal Fire Pumps
14. Section 213400 - Jockey Pumps
15. Section 213900 - Controllers for Fire-Pump Drivers

PART 1 - GENERAL**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of contract, including Division – 1 Specifications sections shall apply to work of this section.

1.2 SUMMARY

- A. This Section includes through-penetration firestop systems for penetrations through the following fire-resistance-rated assemblies, including both empty openings and openings containing penetrating items:
 - 1. Walls and partitions.
 - 2. Smoke barriers.
 - 3. Horizontal barriers (floor/ceiling assemblies)
 - 4. Vertical Service Shaft walls and partitions
 - 5. Construction enclosing compartmentalized areas.
 - 6. Penetrations for the passage of duct, cable, cable tray, conduit, piping, electronics and electrical busways and raceways
 - 7. Closures of openings in walls, floors, and roof decks against penetration of flame, heat, and smoke or gases in fire resistant rated construction.
 - 8. Closure of openings in walls against penetration of gases or smoke in smoke partitions.

1.3 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
 - 1. Fire-resistance-rated load-bearing walls, including partitions, with fire-protection-rated openings.
 - 2. Fire-resistance-rated non-load-bearing walls, including partitions, with fire-protection-rated openings.
 - 3. Fire-resistance-rated floor assemblies.
 - 4. Fire-resistance-rated roof assemblies.
- B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per ASTM E 814; UL 1479; UL 2079:
 - 1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
 - 2. T-Rated Systems: For the following conditions, provide through-penetration firestop systems with T-ratings indicated, as well as F-ratings, where systems protect penetrating items exposed to potential contact with adjacent materials in occupiable floor areas:
 - a. Penetrations located outside wall cavities.
 - b. Penetrations located outside fire-resistance-rated shaft enclosures.
 - c. Penetrations located in construction containing fire-protection-rated openings.
 - d. Penetrating items larger than 100-mm-diameter nominal pipe or 100 sq. cm in overall cross-sectional area.
- C. For through-penetration firestop systems exposed to view, traffic, moisture, and physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
 - 1. For piping penetrations for plumbing and wet-pipe sprinkler systems, provide moisture-resistant through-penetration firestop systems.
 - 2. For floor penetrations with annular spaces exceeding 100 mm (4 inches)

3. In width and exposed to possible loading and traffic, provide firestop systems capable of supporting floor loads involved, either by installing floor plates or by other means.
 4. For penetrations involving insulated piping, provide through-penetration firestop systems not requiring removal of insulation.
- D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: A firm experienced in installing through-penetration firestop systems similar in material, design, and extent to that indicated for this Project, whose work has resulted in construction with a record of successful performance. Qualifications include having the necessary experience, staff, and training to install manufacturer's products per specified requirements. Manufacturer's willingness to sell its through-penetration firestop system products to Contractor or to Installer engaged by Contractor does not in itself confer qualification on buyer.
- B. A manufacturer's direct representative (not distributor or agent) to be on-site during initial installation of firestop systems to train appropriate contractor personnel in proper selection and installation procedures. This will be done per manufacturer's written recommendations published in their literature and drawing details.
- C. Installation Responsibility: Assign installation of through-penetration firestop systems and fire-resistive joint systems in Project to a single qualified installer.
- D. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, through one source from a single manufacturer.
- E. Fire-Test-Response Characteristics: Provide through-penetration firestop systems that comply with the following requirements and those specified in Part 1 "Performance Requirements" Article:
1. Firestopping tests are performed by a qualified testing and inspecting agency. A qualified testing and inspecting agency is UL, or another agency performing testing and follow-up inspection services for firestop systems acceptable to authorities having jurisdiction.
 2. Through-penetration firestop systems are identical to those tested per testing standard referenced in "Part 1 Performance Requirements" Article. Provide rated systems complying with the following requirements:
 - a. Through-penetration firestop system products bear classification marking of qualified testing and inspecting agency.
 - b. Through-penetration firestop systems correspond to those indicated by reference to through-penetration firestop system designations listed by the following:
 - b.1. UL in its "Fire Resistance Directory."
- F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1 Sections.
- G. LEED Submittals:
1. EQ Credit: Low-Emitting Materials Manufacturer's product data for interior sealants, including printed statement of VOC content.
 - a. Cut Sheet
 - b. Material Safety Data Sheet (MSDS) highlighting compliance with VOC limits stipulated in SCAQMD Rule 1168.
 - c. An updated LEED V4 Letter Template, as appropriate to submittal content, with attached updated list of all sealants and sealant primers applied on the interior of the Project.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver through-penetration firestop system products to Project site in original, unopened containers or packages with intact and legible manufacturers' labels identifying product and manufacturer; date of manufacture; lot number; shelf life, if applicable; qualified testing and inspecting agency's classification marking applicable to Project; curing time; and mixing instructions for multicomponent materials.
- B. Store and handle materials for through-penetration firestop systems to prevent their deterioration or damage due to moisture, temperature changes, contaminants, or other causes.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install through-penetration firestop systems when ambient or substrate temperatures are outside limits permitted by through-penetration firestop system manufacturers or when substrates are wet due to rain, frost, condensation, or other causes.
- B. Ventilate through-penetration firestop systems per manufacturer's written instructions by natural means or, where this is inadequate, forced-air circulation.

1.7 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that through-penetration firestop systems are installed according to specified requirements.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate through-penetration firestop systems.
- C. Notify inspecting agency and building inspector at least seven days in advance of through-penetration firestop system installations; confirm dates and times on days preceding each series of installations.
- D. Do not cover up through-penetration firestop system installations that will become concealed behind other construction until inspecting agency and building inspector, if required by authorities having jurisdiction, have examined each installation.

PART 2 - PRODUCTS

2.1 FIRESTOPPING, GENERAL

- A. Compatibility: Provide through-penetration firestop systems that are compatible with one another, with the substrates forming openings, and with the items, if any, penetrating through-penetration firestop systems, under conditions of service and application, as demonstrated by through-penetration firestop system manufacturer based on testing and field experience.
- B. Accessories: Provide components for each through-penetration firestop system that are needed to install fill materials and to comply with "Performance Requirements" Article. Use only components specified by through-penetration firestop system manufacturer and approved by the qualified testing and inspecting agency for firestop systems indicated. Accessories include, but are not limited to, the following items:
 - 1. Permanent forming/damming/backing materials, including the following:
 - a. Slag/rock-wool-fiber insulation.
 - b. Sealants used in combination with other forming/damming/backing materials to prevent leakage of fill materials in liquid state.
 - c. Fire-rated form board.
 - d. Fillers for sealants.
 - 2. Temporary forming materials.
 - 3. Substrate primers.
 - 4. Collars.
 - 5. Steel sleeves.

2.2 FIRE AND SMOKE SEALS

- A. A fire and smoke stopping system is provided at every floor between the slab edges and the cladding wherein the cladding is proud of the slab edges.
- B. Provide fire stopping and smoke seal materials and/or systems to act as fire stop and smoke seals at openings around penetrations, at unpenetrated openings, at projecting or recessed items, and at openings and joints within fire separations and assemblies having a fire-resistance rating.
- C. Provide seals to form draft free and effective barriers against passage of fire, smoke and gases, and to provide and maintain fire resistance ratings not less than the fire resistance ratings of the surrounding floor, wall or other assemblies.
- D. Provide 2 hr. fire separation where installed in all walls and in floor and roof slabs.
- E. Fire Stopping and Smoke Seal Materials and Systems: Certified by ULC in accordance with CAN4-S115 or approved similar, asbestos free, and complying with standards specified herein, by one or more of the specified acceptable manufacturers, installed in accordance with tested assemblies acceptable to authorities having jurisdiction.
- F. Approved Manufacturers:
 - 1. Refer to Section 210007
- G. Service Penetration Assemblies: Certified by ULC or ULI and listed in ULC Guide No. 40 U19 or equivalent ULI or equivalent BSI standards.
- H. Service Penetration Firestop Components: Certified by ULC or ULI and listed in ULC Guide No. 40 U19.13 under the Label Service of ULC or equivalent ULI or equivalent BSI standards.
- I. Materials at Openings Intended for Re-entry Such as Cables: Elastomeric seal (FS-1).
- J. Materials at Openings Around Penetrations for Pipes, Ductwork and Other Mechanical Items for interior applications: Elastomeric seal (FS-1).
- K. Materials at Openings Around Penetrations for Pipes, Ductwork and Other Mechanical Items Requiring Sound and Vibration Control: Elastomeric seal (FS-1).
- L. Interior walls requiring Fire-Rating: Acrylic seal (FS-2)
- M. Interior walls requiring Seismic Control: Elastomeric seal (FS-1).
- N. Materials at Moveable Joints and Spaces: Flexible, elastomeric seal suitable to withstand the required movement and capable of returning to original configuration without damage to the seal and without adhesive or cohesive failure.
- O. Primers: To manufacturer's recommendation for specific material, substrate, and end use.
- P. Water: Potable, clean and free from injurious amounts of deleterious substances.
- Q. Sealants to comply with LEED's low VOC requirement.

2.3 MIXING

- A. For those products requiring mixing before application, comply with through-penetration firestop system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance.
- A. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with written recommendations of firestop system manufacturer and the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.
- C. Masking Tape: Use masking tape to prevent through-penetration firestop systems from contacting adjoining surfaces that will remain exposed on completion of Work and that would otherwise be permanently stained or damaged by such contact or by cleaning methods used to remove smears from firestop system materials. Remove tape as soon as possible without disturbing firestop system's seal with substrates.

3.3 THROUGH-PENETRATION FIRESTOP SYSTEM INSTALLATION

- A. General: Install through-penetration firestop systems to comply with "Performance Requirements" Article and firestop system manufacturer's written installation instructions and published drawings for products and applications indicated.
- B. Install forming/damming/backing materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
 - 1. After installing fill materials, remove combustible forming materials and other accessories not indicated as permanent components of firestop systems.
- C. Install fill materials for firestop systems by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
 - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

- A. Identify through-penetration firestop systems with preprinted metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 150 mm (6 inches) of edge of the firestop systems so that labels will be visible to anyone seeking to remove penetrating items or firestop systems. Use mechanical fasteners for metal labels. For plastic labels, use self-adhering type with adhesives capable of permanently bonding labels to surfaces on which labels are placed and, in combination with label material, will result in partial destruction of label if removal is attempted. Include the following information on labels:

- 1. The words "Warning - Through-Penetration Firestop System - Do Not Disturb. Notify

- Building Management of Any Damage."
- 2. Contractor's name, address, and phone number.
- 3. Through-penetration firestop system designation of applicable testing and inspecting agency.
- 4. Date of installation.
- 5. Through-penetration firestop system manufacturer's name.
- 6. Installer's name.

3.5 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce through-penetration firestop systems complying with specified requirements.

3.6 CERTIFICATION

The Contractor shall secure certification from the Manufacturer (not distributor nor supplier) that the Installation done by the Contractor is in conformance set by the U.L.

END OF SECTION 078413

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PART 1 – GENERAL**1.1 WORK INCLUDED**

- A. These Specifications are an integral part of the Contract Documents. Tendering and Contract Requirements and Division 1, General Requirements apply to all Division 21 Specification Sections.
- B. Work in the Specifications is divided into descriptive Sections which are not intended to delegate functions or work to any specific Subcontractor or identify absolute contractual limits between Subcontractor, nor between the Contractor and his Subcontractor. The requirements of any one Section apply to all other Sections, for example: the motor service factor requirement. Refer to other Divisions and Sections to ensure a completed operational product and fully coordinated standard of work.
- C. The direction to 'provide' equipment, materials, products, labour and services shall be interpreted to 'supply, install and test' the Division 21 work indicated on the Drawings and specified in the Specifications.
- D. Provide and include in the Contract Price Division 21 work including mechanical components and normal system accessories not shown on the Drawings or stipulated in the Specifications, and required to ensure completed operational systems and a fully coordinated standard of Work acceptable to the Consultant and all authorities having jurisdiction.
- E. The work essentially shall include, but shall not all necessarily be limited to the following items:
 - 1. Submission of technical specifications and samples of all supply items for approval by the Consultant(s).
 - 2. Submission of shop drawings of all items for fabrication for approval by the Consultant(s) prior to fabrication.
 - 3. Application and securing of required permits and licenses including facilitating inspection by governing agencies and payment of all fees levied therewith.
 - 4. Supply and installation of the following:
 - a. Pipes, fittings and accessories for the complete sprinkler system installation including water flow indicators, valves, supervisory switches pressure gauges, etc. except fire pumps, jockey pump and accessories.
 - b. Piping from fire tank to fire pumps including level sensors, pressure and flow switches related to fire pump operation;
 - c. Provide 50 LBS wheeled type fire extinguisher to the following, LVSG Rooms, Transformer Room, Genset Room.
 - d. Valves, pipes, fittings and accessories for Fire Department Connection;
 - e. Sprinkler heads;
 - f. Fire Hose Cabinets complete with 30 M hose and 10 lbs. multipurpose dry chemical fire extinguisher; and
 - g. Wheeled-type (50 lbs.) fire extinguishers;
 - 5. Provision for interfacing with others.
 - 6. Fire stopping of all vertical and/or horizontal pipe penetration to fire rated areas.

7. Miscellaneous Works:
 - a. Hacking of non-structural wall and partitions to provide opening for pipes and sealing of opening around sleeves and pipes including provision of escutcheon plates.
 - b. Grouting of opening in walls after such pipes are in place and sealing of all such openings if not used.
 - c. Flushing prior to charging of newly installed fire protection system.
 - d. Restoration/repair of existing structures damaged during installation.
 - e. Miscellaneous items and other provisions required to maintain cleanliness level of adjacent areas during the entire duration of construction.
 - f. Full instruction after completing the job to the Maintenance Personnel regarding operation and maintenance operation of the entire installation. Provide complete printed/type instruction booklets (hardbound) covering maintenance operation and adjustment of each piece of equipment and list of spare parts each.
 - g. Provide fire stopping materials same as "Hilti" for pipe penetrations.
8. Testing and commissioning.
9. Submission of five (05) sets of operations and maintenance manuals and as-built plans.
10. Training of Owner's plant operators on the system's maintenance and operation.
11. Coordination with other trades for special requirements for this package. (i.e. concrete pads, block-outs, relays, etc.)
12. Provision of guarantee as specified in the Specifications.

1.2 INTENT/PHASING

- A. Mention in the Specifications or the indication on the Drawings of equipment, materials, operation and methods, requires provision of the quality noted, the quantity required, and the systems complete in every respect.
- B. Consider the Specifications as an integral part of the accompanying Drawings. Any item or subject omitted from one or the other, but which is either mentioned or reasonably implied, shall be considered as properly and sufficiently specified.
- C. Be completely responsible for the acceptable condition and operation of all systems, equipment and components forming part of the installation or directly associated with it. Promptly replace defective materials, equipment and parts of equipment and repair related damages.
- D. Phasing shall be scheduled with the Owner.

1.3 COORDINATION

- A. Coordinate and schedule Division 21 work with all other work in the same area or with work which is dependent upon Division 21 work so as to facilitate mutual progress.
- B. Identify and resolve interference problems prior to prefabrication and installation of equipment. Submit interference drawings for review upon Consultant Request.
- C. Examine the site and all Contract Documents prior to bid submission. No allowance will be made for any difficulties encountered due to any features of the building, methods of construction, site or surrounding public and private property which existed up to the bid close.

1.4 REFERENCE STANDARDS

- A. Provide new materials and equipment of proven design and quality. Provide current models of equipment with published ratings certified by recognized local and international testing and standards agencies.
- B. Workmanship and installation methods shall conform to the best modern practice. Employ skilled tradesmen to perform work under the direct supervision of fully qualified personnel.
- C. Install equipment in strict accordance with manufacturers written recommendations.
- D. Meet NFPA and other industry standards in the selection and provision of equipment, materials, pipe and components and systems.
- E. Meet NFPA and Manufacturer's Standards for the supply and installation of all equipment.
- F. Meet the additional selection, sizing and performance criteria specified in this Specification.

1.5 DRAWINGS AND MEASUREMENTS

- A. Drawings show general design and arrangement of mechanical system installation, and are diagrammatic. Obtain further clarification of Drawings or Specifications from Consultant prior to installation.
- B. Drawings do not indicate exact Architectural, Structural or Electrical features. Examine Drawings prior to laying out.
- C. Do not scale Drawings to order materials. Take field measurements before ordering and fabricating materials.
- D. Clarify 'roughing-in' requirements of equipment which is not part of Division 21 work before proceeding.
- E. Leave areas clear where space is indicated as reserved for future equipment and where space is required to maintain equipment. Maintenance clearances in addition to providing for servicing of equipment, shall allow for removal and reinstallation of replaceable items such as motors, coils and filters.

1.6 REGULATORY REQUIREMENTS

- A. Meet the requirements and recommendations of the local Municipal Ordinance.
- B. Do not reduce the quality of work specified and/or shown on the Drawings because of regulatory requirements.
- C. In general, and as applicable, the physical and chemical properties, the characteristics and the performance of Division 21 work shall meet the requirements of recognised agencies including those listed herein:

FCP	-	Fire Code of the Philippines
NBCP	-	National Building code of the Philippines
ANSI	-	American National Standards Institute
IMC	-	International Mechanical Code
ASME	-	American Society of Mechanical Engineers
ASTM	-	American Society for Testing and Materials
AWWA	-	American Water Works Association

NFPA	-	National Fire Protection Association
NBC	-	National Building Code (USA)
UL	-	Underwriter's Laboratories Inc.
ULC	-	Underwriter's Laboratories of Canada

- D. Give all necessary notices, obtain all permits and pay for all governmental fees, taxes and other costs in connection with the work. File all necessary Contract Documents, prepare submissions and obtain approvals of regulatory bodies having jurisdiction.

1.7 CHANGES TO CONTRACT WORK

- A. Do not proceed with any changes to the Work without written authority from the Owner.
- B. Follow procedures outlined in Tendering and Contract Requirements for administration and execution of Contract revisions.
- C. Quotations for changes to Division 21 work shall be based on:
1. Methods either approved or directed by the Consultant.

1.8 PREPURCHASED EQUIPMENT

- A. Where equipment has been pre-purchased by the Owner for installation by Division 21, assume complete responsibility for acceptance, delivery schedule, off-loading, storage, rigging, installation, protection, start-up and warranty of this equipment, all as if the equipment were provided by Division 21.
- B. The responsibilities of the equipment supplier are delineated in the pre-purchase documents which are available for Contractor review during the bid period.
- C. The following equipment has been pretendered in order to ensure equipment delivery in time to meet the building construction schedule.
- D. Include in Contract Price, the cost of the following pre-purchased equipment.
- E. The Owner shall bear the equipment and FOB job site shipping costs directly.
- F. Request from the Owner, full details of the equipment and the manufacturer's Shop Drawings. Include related information in the Operating and Maintenance Manual.
- G. Assume extensions of warranties to meet specified times.

1.9 WARRANTY

- A. Meet the requirements of Tendering and Contract Requirements.
- B. Unconditionally warrant all equipment, material and workmanship for not less than one year from date of Substantial Performance of the Work, or for longer periods when stated elsewhere in the Specifications.
- C. If any equipment or material does not match the manufacturer's published data or specially supplied rating schedules during performance tests, replace without delay the defective equipment or material. Bear all associated costs of replacement without charge to the Owner. Adjust all components to achieve the proper ratings.
- D. Promptly correct defects and deficiencies which originate during the warranty period. Pay for resulting damage.

1.10 INSTRUCTIONS TO BIDDERS

- A. Submit Supplementary Mechanical Bid Form. Failure to comply with the stated requirements of the Bid Form may nullify the bid.
- B. The Bidder is invited to submit additional alternative prices not specifically requested with the Bid.
- C. Alternative prices may be used to establish the lowest Contract Price.
- D. The lowest or any Bid will not necessarily be accepted.

1.11 CASH ALLOWANCES

- A. Include in tender, cash allowances for the following:
 - 1. Street Connections
 - 2. Water Meter
 - 3. Balancing
 - 4. Pretender Equipment
- B. Payment against cash allowances will be made only upon receipted verification of approved statements. Copies of supplier's invoices will be required to substantiate charges against an allowance.
- C. Do not charge labour, administration, overhead and profit from cash allowance. It is deemed to be included in Contract Price.
- D. Remaining portion of cash allowances not authorised for use shall revert to Owner.

1.12 SEPARATE PRICES

- A. Submit separate prices on the Bid Form and express as a credit or an extra to the Stipulated Bid Sum.
- B. Calculation of the Contract Price will include separate prices consistent with their acceptance or rejection by the Owner.

1.13 DRAWINGS AND APPROVALS**A. Interpretation of Drawings**

- 1. The Specification and any drawings or other documents attached thereto and issued by the Employers Representative shall be deemed to include, whether or not specifically mentioned or shown, any materials, accessories or work as may be necessary for the satisfactory completion of the Works. The Sub-Contractor shall make due allowance in his Tender for such materials or work.
- 2. Where a discrepancy exists between the drawings and Specification, or where the interpretation of either is in doubt, the Sub-Contractor shall obtain written clarification on such matters before submitting his Tender. Any such clarification from the Employer's Representative to the Sub-Contractor or vice versa dated prior to the submission of the Tender, shall form part of the Sub-Contract Documents. If no clarification is requested and obtained by the Sub-Contractor the Employer's Representative reserves the right to select either option irrespective of the allowances the Sub-Contractor has made in his tender.

B. Tender Drawings

1. Tender Drawings are generally diagrammatic and indicative of work to be installed. Run and arrangement of piping and the positioning of apparatus shall be approximately as indicated.
2. The Tender Drawings are primarily intended to enable the Tender to prepare his estimate and submit Tender. Where runs of piping, cables, conduits, etc. are shown to small scale these do not necessarily indicate exact positions, and all offsets fittings and accessories that may be required are not necessarily shown. The Tender Drawings are based on agreement with the Employer taking into account co-ordination with other services and no alteration in principle will be allowed without approval.
3. If directed by the Employer's Representative, the Sub-Contractor shall, without extra charge, make reasonable modifications in the layout as needed to execute properly the work and prevent conflicts with the works of other trades.
4. After the award of the Sub-Contract, the Employer's Representative will, without charge, furnish two copies of the drawings and Specifications and will within a reasonable time also furnish such further drawings as are reasonably necessary to enable all the Employers Representative's Instructions to be carried out. The Employer's Representative will also provide all details which in the opinion of the Employer's Representative are necessary for the execution of any part of the work.
5. Additional copies of the drawings and the Specification can be provided to the Sub-Contractor upon written request to the Employer's Representative, but the Employer's Representative will charge for such additional copies at current commercial rates.

C. Sub-Contractors Drawings

1. The Sub-Contractor shall prepare, or be responsible for obtaining, the following drawings:
 - a. Installation Drawings.
 - b. Manufacturer's Shop Drawings.
 - c. Builders Work Drawings.
 - d. Progress Drawings
 - e. Record Drawings and Charts.
2. The symbol notation on all drawings shall be the same as the Tender Drawings. New symbols, not previously used on the Tender Drawings shall be agreed with the Employer's Representative. All drawings shall have a stenciled title block and stenciled notes.
3. The Sub-Contractor shall be responsible for verifying the accuracy of all dimensions abstracted from Tender Drawings and used in the preparation of his drawings.

D. Installation Drawings

1. The Sub-Contractor shall, before the relevant work proceeds, prepare and submit for approval by the Employer's Representative, all Installation Drawings showing details of his proposals for the execution of the Sub-Contract Works. The Installation Drawings shall be based on the Tender Drawings, and shall take into account any modifications, either to the building or to the installation which may have taken place, and incorporate details of the actual items of plant and equipment to be installed.

2. They shall be in such detail and with all necessary dimensions as to enable the Sub-Contract Works to be installed, and shall indicate all piping and fittings necessary for installation, and also particular installation methods to be applied in certain instances.
3. The Sub-Contractor shall similarly prepare all necessary Schedules of equipment, and necessary schematic diagrams, including internal diagrams for items of electrical equipment and diagrams showing the inter-connections between different items.
4. The Sub-Contractor's Installation Drawings shall be prepared to a scale of 1:100 for all services in the building and 1:50 or 1:20 for all plant rooms and similar spaces, unless otherwise approved by the Employer's Representative.
5. The Sub-Contractor shall produce and submit for approval drawings detailing and dimensioning the following:
 - a. Site distribution, piping routes.
 - b. General layout drawings of all plant and equipment included in the Contract.
 - c. Schematic distribution for main and sub-main distribution.

E. Manufacturer's Shop Drawings

1. The Sub-Contractor shall submit for review shop drawings of any item of plant or equipment produced by a manufacturer or equipment supplier indicating principle dimensions, fixings, connections and all other relevant details. These shall include drawings of all control, and instrumentation panels, pumps and other equipment as requested by the Employer's Representative.
2. The Sub-Contractor shall provide engineering drawings showing the construction, external and internal layout of panels and wiring diagrams comprising internal wiring, schematics of interlocking and external wiring diagrams, for the complete system in the panels. The drawings shall also show all electrical, pipework and capillary connections from the panels to external equipment.

F. Sub-Contractor's Approval of Manufacturer's Shop Drawings

1. All drawings, schedules or other information provided by Manufacturers, Nominated Suppliers, Nominated Sub- Contractors or Specialist Contractors shall be approved by the Sub-Contractor and such approval shall ensure that all requirements of the Sub-Contract documentation have been incorporated.
2. When this procedure has been completed, the Sub-Contractor shall forward paper prints of the approved drawings, or copies of the approved schedules or their information to the Employer's Representative in a similar manner to that described for the Installation drawings.
3. No order to a Manufacturer, Nominated Supplier, Nominated Contractor or Specialist Contractor, to commence manufacture/installation shall be given until written approval has been given by the Employer's Representative.
4. Any costs arising from failure to meet the above conditions shall be borne by the Sub-Contractor at no cost to the Sub-Contract.

G. Builders Work Information & Drawings

1. The Sub-Contractor shall provide fully detailed Builders Work drawings to show requirements for architectural or structural provisions necessary to facilitate the execution of the Sub-Contract Works, and allow their integration into the project. These drawings shall show dead and live loads of all plant, and fully dimensioned details of all plant bases, wall chases, and penetrations.

2. This information shall be prepared in sufficient time for incorporation in the Main Building Contractors programme.
3. In cases where preliminary builders' work and structural information has already been given by the Employer's Representative, such information shall be confirmed by the Sub-Contractor (including confirmation of weights of items of equipment, sizes of access ways, etc.) and incorporated on his drawings.
4. The Sub-Contractor shall provide templates for, and supervise all builders' work required, including drilling and plugging of walls, floors and ceilings for securing of brackets, and other builders work as is considered normal to the trade.
5. The details required by the Main Building Contractor are to be provided as directed, which may require advance information to be provided by the Sub-Contractor before the Works defined in this Specification are to commence. The Sub-Contractor shall be responsible for checking any details that may have been given before commencement of the Works to ascertain that the said advance details are correct.
6. The Sub-Contractor shall be liable for all costs associated with the late submission or omission of builders work information.

H. Progress Drawings

1. The Sub-Contractor shall arrange for a full set of white prints of Installation Drawings to be kept on the Site showing the progress of all work in connection with the Sub-Contract. Such prints shall be kept up-to-date before each site progress meeting, and all conduit, cable, pipe and trunking runs, positions of equipment and apparatus shall be recorded on the drawings as they are installed.
2. The Progress Drawings shall be available for inspection at any time by the Employer's Representative and Main Building Contractor.
3. The Sub-Contractor shall include for his representative to keep a diary recording the progress of the works and details of all instructions received. The diary shall be at the disposal of the Employer's Representative as and when required.

I. Record Drawings and Charts

1. The Sub-Contractor shall issue draft copies of Record Drawings, showing the whole of the services as installed, to the Employers Representative one month prior to the start of commissioning.
2. Within one month of the Practical Completion of the installations, the Sub-Contractor shall provide to the satisfaction of the Employer's Representative one durable plastic negative and one CD copy (Autocad) and four complete final sets of white prints showing the whole of the services installed. Prior to this formal issue, the Sub-Contractor shall submit two copies of his proposed finalized Record Drawings to the Employer's Representative for approval.
3. Two sets of drawings for symbols shall be submitted, one of the same size as the tender drawings, the other set shall be of A4 size suitable for eventual inclusion in the Operation and Maintenance Manual.
4. The complete symbol notation used for all Record Drawings shall be computer generated.
5. The preparation of the Record Drawings shall proceed during the installation of the Works as each section is completed. The Employer's Representative shall be allowed to inspect the drawings on request during their preparation.
6. In addition to the foregoing Record Drawings, the following charts and drawings shall be laminated in plastic and hung in the plant rooms and switchgear rooms:
 - a. Plant room key Drawings: showing all plant item numbers, locations and duties.

- b. Control Schematics
- c. Electrical system schematic diagrams

J. Submission of Drawings and Equipment for Review

1. Information for review must be submitted in accordance with the agreed programme of work and in packages relating to complete buildings or previously agreed parts of the building.
The packages must include:

- a. Installation drawings.
- b. Builders work drawings.
- c. Associated Manufacturer's shop drawings.
- d. Technical information of proposed equipment and materials.
- e. Any other relevant information required by the Employer's Representative.

Each submission must be accompanied by a letter which:

- a. Identifies the contents of the submission in detail.
- b. Refer to previous submissions of the information and any relevant correspondence.
- c. Refers to the purpose of the submission and any other requirements of the Sub-Contractor.

K. Employer's Representative's Approval

1. The Sub-Contractor shall obtain the Employer's Representatives review of his information before it is used for ordering, fabrication or installation. The form of review will be an examination of the drawings and/or samples by the Employer's Representative to ensure that the design criteria and engineering principles described in the Tender documents have been correctly interpreted and applied by the Sub-Contractor.
2. The review will not entail any checking of working dimensions on the drawings.
3. The Sub-Contractor must carry out his own checking procedure before submitting information for review, this checking must cover not only his own work, but that of Manufacturers and Specialists for whom he is responsible.
4. The review of information by the Employer's Representative will in no way relieve the Sub-Contractor of his responsibility for error in his work or of his other contractual responsibilities and obligations.
5. The Sub-Contractor shall allow a period of 2 weeks in his programme for the Employers Representative to review and return the Sub-Contractor submission with comment. The Sub-Contractor shall also indicate in his programme time allowed for resubmission of drawings not allowed to be used for installation by the Employer's Representative.

L. Review Procedure for Sub-Contractor Submission

1. Five (5) copies of all information and drawings shall be submitted to the Employer's Representative. One copy will be retained by the Employer's Representative and the other copy will be returned to the Sub-Contractor.

The information will be returned and marked either:

Stamp	Interpretation
Approved/Unaltered	Fabrication, manufacture, or construction may proceed providing submittal complies with the Contract Documents.
Approved with corrections /comments as noted prior to general issue	Fabrication, manufacture, or construction may proceed providing submittal complies with the Contract Documents and the Engineer's notation are complied with.
For Re-submission	The submittal does not comply with the Contract Documents; do not proceed with fabrication, manufacture, or construction. The work and shop drawings are not permitted at the job site. Re-submit appropriate shop drawings.

2. Modifications and variations found to be necessary after the initial review has been given must be re-submitted for further approval in the abovemanner.
3. Revision marks must be included on all revised drawings, and the revisions must be fully and clearly described.
4. Six copies of all reviewed drawings and noted as "Approved/Unaltered" shall be submitted to the Employers Representative for general distribution to the Main Building Contractor and other interested parties.

M. Co-ordination

1. The Installation Drawings shall illustrate that the Sub-Contractor design has been coordinated and integrated with that of other Sub-Contractors, the structure, and building elements, before work commences. In addition to the Works for which he is responsible, the drawings must show the structure, adjacent building elements and the zone required by other Sub-Contractor to install, operate and maintain their equipment.
2. If the Sub-Contractor deviates from the design intent of the Tender drawings, he shall ensure that this deviation either does not involve a change in any of the other Sub-Contractor installations or that any change necessary in the other Sub-Contractor installations does not incur an additional cost to their Sub-Contract.
3. The Sub-Contractor shall be fully liable for any cost incurred through his lack of co-ordination.

1.14 SAMPLES

- A. Submit samples or provide site mock-up of proposed materials upon request of the Consultant, including:
 1. Valves, valve tags and equipment identification plates
 2. Pipes and Fittings
 3. Hangers, pipe supports, inserts and fastening devices
 4. Sprinkler heads and guards
 5. Access doors and panels
 6. Alarm motor gong, alarm valves and pressure gauges
 7. ECMS instrumentation
 8. Supervisory switch
 9. Inspector's test and drain assembly
- B. Provide site mock-up of proposed materials before proceeding.

1.15 COORDINATION DRAWINGS

- A. Prior to commencement of work, submit for Consultant review, pipe and equipment interference and sleeving drawings for each floor level and for all Division 21 work. Drawings must be coordinated and certified correct for review.
- B. Coordination drawings shall be to a scale sufficient to show the necessary details. Submit for review, using the same procedures as specified for Shop Drawings.
- C. Prepare drawings in conjunction with other Divisions, wherever possible conflict due to the positioning of Division 21 equipment, piping or ductwork exists.
- D. Dimension proposed location of Division 21 work with respect to building elevations and established grid lines.
- E. Prepare fully dimensioned detail drawings of all shafts, duct spaces and pipe spaces. Show sleeving, recessed and formed holes required in concrete for Division 21 work. Include information pertaining to access, clearances, tappings, housekeeping pads, drains and electrical connections.
- F. Base information used to prepare drawings on reviewed Shop Drawings.
- G. Provide field drawings with position of various services when required by Consultant.
- H. Submit a list of access doors and panels showing proposed type, size and location. Coordinate drawings with Architectural detail drawings and reflected ceiling plans prior to submission.

1.16 RECORD DRAWINGS

- A. Meet the requirements of General and Supplementary Conditions.
- B. Suitably store and protect drawings on site and make available at all times for inspection.
- C. Record inverts of underground piping at building entry/exit and below floor slab at each branch, riser base, change in direction as well as at least three points on straight runs.
- D. Show locations of access doors and panels and identify the equipment and components that they serve.
- E. Submit in electronic form (CD) a copy of the approved as-built drawings.

1.17 OPERATING AND MAINTENANCE MANUALS

- A. Meet the requirements of General and Supplementary Conditions.
- B. Submit three copies for review at least ten weeks before completion date.
- C. Ensure that the terminology used in various sections of the manual is consistent.
- D. Each manual shall contain the following information:
 - 1. Description of each system with description of each major component of system
 - 2. Complete sets of page size equipment Shop Drawings
 - 3. Equipment manufacturer's installation, start-up and operation manuals
 - 4. Equipment manufacturer's recommended spare parts lists
 - 5. Equipment wiring diagrams

6. Lubrication schedule for all equipment
7. Equipment identification list with serial numbers
8. Page size valve tag schedule and flow diagrams
9. Final balancing reports
10. Water treatment procedure and tests
11. Control drawings, sequences of operation
12. Extended warranty documentation if applicable

1.18 PROPOSED SEPARATION OF WORK BETWEEN THE TRADES

- A. The specifications describe in detail the proposed work included for each trade when the main Contractor divides the work among their Sub-Contractors. The following summary is an outline of the work to be “Provided”, “Furnished” or “Installed” by each of the trades included in the contract, i.e., Plumbing (Div.22) & Sprinkler (Div.21) HVAC, [Building Management System] (Div. 23), Electrical (Div. 26) and other Divisions 1-14.
- B. In the absence of more detailed information, consider the list as specific instructions to include such work in the named contract.
- C. Abbreviations are as follows:
 1. “OD” - Other Division of the Contract (not Electrical or Mechanical)
 2. “Plb” - Plumbing – Division 22
 3. “Spr” - Sprinkler – Division 21
 4. “Mech” - Mechanical – Division 23
 5. “Elec” - Electrical – Division 26
 6. “BMS” - Building Management System – Division 23
 7. “f” - Furnished
 8. “I” - Installed
 9. “p” - Provided (Furnished and Installed)

<u>ITEM</u>	<u>OD</u>	<u>Plb</u>	<u>Spr.</u>	<u>Mech.</u>	<u>Elec.</u>	<u>BMS</u>	<u>Remarks</u>
Motors for Mechl., Plumbing, Fire Protection Equip't	—	p	p	p	—	—	
Feeder Cables from Electrical Panels to Motor Controls	—	—	—	—	p	—	Cables to be terminated in the Motor Controls by each trade.
Motor Controls for Mechl., Plumbing, Fire Protection Equipment	—	p	p	p	—	—	Specification and drawings delineate detailed exceptions.
Wiring for Mechl., Plumbing, Fire Protection Equip't Motors including the feeder cables from motor controller	—	p	p	p	—	—	
Wiring for Mech'l Equipment Motor Controls and Alarms	—	p	p	p	—	p	Specifications and drawings delineate in detail the work to be performed by each trade.
Temporary Light and Power	—	—	—	—	—	—	As per Contract Documents.
Temporary Water	—	—	—	—	—	—	As per Contract Documents.
Toilets	—	—	—	—	—	—	As per Contract Documents.
Temporary Fire Protection	—	—	—	—	—	—	As per Contract Documents.
Hoisting	p	p	p	p	p	p	
Rigging	p	p	p	p	p	p	
Bracing of Building for Safe Rigging	p	—	—	—	—	—	

ITEM	OD	Plb	Spr.	Mech.	Elec.	BMS	Remarks
Cutting, Chasing & Patching	p	—	—	—	—	—	Cost where due to late installation or improper coordination of work is the responsibility of the delinquent trade.
Framed Slots and Openings in Walls, Decks and Slabs	p	—	—	—	—	—	Includes drilling of holes when required. Cost where due to late installation or improper coordination of work is the responsibility of the delinquent trade.
Sleeves	p	p	p	—	—	—	
Waterproof Sealing of Sleeves through Waterproof							
Slabs, Decks and Walls	—	p	p	p	p	p	
Fireproof Sealing of Excess Openings in Slabs, Decks and Fire Rated Walls	—	p	p	p	p	p	
Excavation and Backfill Inside Buildings	—	p	p	p	p	p	
Excavation and Backfill Outside Buildings	p	—	—	—	—	—	Coordination with the trades. Cost where due to late installation or improper coordination of work is the responsibility of the delinquent trade.

<u>ITEM</u>	<u>OD</u>	<u>PIb</u>	<u>Spr.</u>	<u>Mech.</u>	<u>Elec.</u>	<u>BMS</u>	<u>Remarks</u>
Keep Site and Excavation Free From Surface Water During Construction	p	—	—	—	—	—	
Fastenings	—	p	p	p	p	p	
Supports	p	p	p	p	p	p	
Concrete Encasement of Electrical Conduits	—	—	—	—	p	—	
Below Grade							
Drainage Inside Building	—	p	—	—	—	—	
Base Flashing of Electric Conduits Through Roof (Pitch Pockets)	p	—	—	—	—	—	Cap flashing by Trade.
Electrical Handholes, and Covers	—	—	—	—	p	—	
Finish Painting (does not include I.D. marks or color coding specified and provided by each trade)	p	p	p	p	p	p	
Finished Walls and Ceiling Access Doors, Panels and Supporting Frames	p	—	—	—	—	—	Supplying list of location of all items requiring access doors included in the Division requiring same.

ITEM	OD	Plb	Spr.	Mech.	Elec.	BMS	Remarks
Plaster Rings and Frames	<u>i</u>	<u>f</u>	—	—	<u>f</u>	—	Plaster rings and frame furnished in electric only for lighting fittings which are so equipped.
Rubbish Removal	<u>p</u>	<u>p</u>	<u>p</u>	<u>p</u>	<u>p</u>	<u>p</u>	Where one trade furnishes and another installs, the installing trade removes the shipping and packing materials which accumulate.
Special Tools for Equipment Maintenance	<u>f</u>	<u>f</u>	<u>f</u>	<u>f</u>	<u>f</u>	<u>f</u>	
Electric Power Consuming Items and Controls for Other than Mechanical Equipment, e.g. Motorized Doors	<u>p</u>	—	—	—	—	—	
Concrete Foundations, Pads, Pits, Curbs, and Bases Inside Buildings	<u>p</u>	—	—	—	—	—	Furnishing exact dimensions of anchors, vibration mounts and templates included in each trade providing the associated equipment.
Concrete Foundations Pads and Bases Outside Buildings	<u>p</u>	—	—	—	—	—	Furnishing exact dimensions of anchors, vibration mounts and templates included in each trade providing the associated equipment.
Masonry Pits	<u>p</u>	—	—	—	—	—	Furnishings of covers and associated frames included in each trade.

<u>ITEM</u>	<u>OD</u>	<u>Plb</u>	<u>Spr.</u>	<u>Mech.</u>	<u>Elec.</u>	<u>BMS</u>	<u>Remarks</u>
Sump Pits	p	—	—	—	—	—	Furnishing of covers and associated frames included in each trade.
Concrete Lined Trenches inside Building Foundations	p	—	—	—	—	—	
Prime Coat Painting	—	p	p	p	p	p	
Field Touch-up Painting of Damaged Shop Coats	—	p	p	p	p	p	
Rustproofing Field Cut and Assembled Iron Supporting Frames and Racks	—	p	p	p	p	p	
Grating and Exterior Wall Louvers	p	—	—	—	—	—	
Duct Connections to Louvers	—	—	—	p	—	—	
Equipment Delivered and Set in Place	p	—	—	—	—	—	Except Mechanical and Electrical Equipment by Divisions 23, & 26.
Vinyl Tape or Painted Color-Coding, Banding Arrows and Similar Identification for Mechanical and Electrical Work	p	p	p	p	p	p	

<u>ITEM</u>	<u>OD</u>	<u>Plb</u>	<u>Spr.</u>	<u>Mech.</u>	<u>Elec.</u>	<u>BMS</u>	<u>Remarks</u>
Underfloor and Header Duct	—	—	—	—	p	—	Responsibility for coordination is included in this Section.
Lighting Fixtures	—	—	—	—	p	—	See Drawings.
Elevators, Escalators and Dumbwaiters	p	—	—	—	—	—	Power connections to disconnect switch included in Electrical Section.
Catwalks and Ladders to Electrical Equipment	p	—	—	—	—	—	
Food Service Equipment	p	—	—	—	—	—	Line connections included in each trade.
Services to Food Service Equipment	—	p	p	p	p	—	
Laundry Equipment	p	—	—	—	—	—	Line connections included in each trade.
Services to Laundry Equipment	—	p	p	p	p	—	
Roughing to Equipment Furnished by Others	—	p	p	p	p	—	

- D. Each Division is required to supply all necessary supervision and coordination information to any other Division supplying work to accommodate that Division.
- E. For items which are to be installed but not furnished as part of this Division, the electrical work includes:
1. Coordination of their delivery.
 2. Unloading from delivery trucks driven into any point on the property line at grade level.
 3. Safe handling and field storage up to the time of permanent placement in the project.
 4. Correction of any damage, defacement or corrosion to which they may have been subjected.
 5. Field make-up and internal wiring as indicated for their proper operation.
 6. Mounting in place.

7. Connection to building wiring, including the purchase and installation of all termination junction boxes necessary to adapt and connect them to this wiring.

PART 2 – PRODUCTS**2.1 EQUIPMENT AND MATERIALS**

- A. Provide products and materials that are new, clean, free of defects, and free of damage and corrosion.
- B. Products and materials shall not contain asbestos, PCB, CFCs, Halons, or any other material which is installed considered hazardous by the authority having jurisdiction.
- C. Replace materials of less than specified quality and relocate work incorrectly installed as directed by the Engineer or its authorized representative.
- D. Provide name/data plates on major components of equipment with manufacturer's name. Model number, serial number, capacity data and electrical characteristics attached in a conspicuous place.
- E. Install materials and equipment with qualified trades people.
- F. Maintain uniformity of manufacturer for equipment used in similar application and sizes.
- G. Fully lubricate equipment where required.
- H. Follow manufacturer's instructions for installing, connecting, and adjusting equipment. Provide a copy of such instructions at the equipment during installation.
- I. Where factory testing of equipment is required to ascertain performance, and attendance by the Owner's representative is required to witness such tests, associated travel costs and subsistence shall be paid for by the Contractor.
- J. Equipment capacities, ratings, etc., are scheduled or specified for job site opening conditions. Equipment sensitive to altitude shall be derated with the method of derating identified on the submittals.
- K. Enclosures for electrical equipment installed in mechanical equipment rooms shall be NEMA type 1 gasketed. Enclosures for electrical equipment installed outdoors shall be NEMA type 3R.
- L. Energy consuming equipment shall meet local energy ordinances.

PART 3 – EXECUTION**3.1 INSPECTION, TESTING AND CERTIFICATES**

- A. Periodic inspections of the work in progress will be made to check general conformity of the work to the Contract Documents. Observed deficiencies will be reported. Correct deficiencies immediately.
- B. Meet the requirements of all laws, bylaws, codes, regulations and authorities having jurisdiction.
- C. Where the Contract Documents, instructions or the governing authorities require Division 21 work to be tested, inspected or approved, give sufficient notice of its readiness for inspection and schedule the date and time for such inspection.

- D. Uncover Division 21 work that is covered up without consent, upon Consultant request, for examination and restore at no extra cost to the Owner.
- F. Furnish certificates and evidence that Division 21 work meets the requirements of authorities having jurisdiction.
- G. Correct deficiencies immediately upon notification.

3.2 TEMPORARY SERVICES

- A. Provide temporary mechanical services in accordance with the requirements of Section 1300.
- B. Make connections to temporary power source provided and provide extensions for use by Division 21.
- C. Install and maintain temporary fire protection services as required by the authorities having jurisdiction.
- D. When the permanent water service is installed, it shall be used to supply water for the use of Other Contractors.
- E. Perform operations necessary for checking, testing and balancing after written approval is given to start up systems. Ensure that care is taken to protect equipment from damage and to prevent distribution of dust through duct systems.
- F. Do not use permanent plumbing, heating or air conditioning systems for temporary services during construction, except with written permission from Consultant.

3.3 CUTTING AND PATCHING

- A. Give notification in time to Other Contractors of openings required for Division 21 Work. Supply accurate details of location and size. When this requirement is not met, bear the cost of cutting and patching.
- B. In existing work, cutting, patching and restoration of finished work to original condition will be carried out by Other Contractors at the expense of Division 21.
- C. Obtain written Consultant approval before cutting openings through structure.
- D. Where new work connects with existing and where existing work is altered, cut, patch and restore to match existing work.

3.4 PROTECTION

- A. Protect all Division 213 work from damage. Keep all equipment dry and clean at all times.
- B. Cover openings in equipment, pipes and ducts, with caps or heavy gauge plastic sheeting until final connections are made.
- C. Repair any damage caused by improper storage, handling or installation of equipment and materials.
- D. Protect equipment, pipes and temporary services installed by Division 21 from weather damage.

3.5 PAINTING, LABELLING AND FINISHING**A. Materials**

1. All parts of the work installed under this Specification shall be painted with approved high quality enamel paints, except those items specified as being painted by others or otherwise exempted from painting in this section of the Specification.
2. Paint shall be selected to withstand the temperature on the surface which it is applied, and shall be suitable in all respects for the environmental conditions in which it shall be located.
3. All paint used shall be of one approved manufacture, and finishes shall be full gloss unless otherwise specified.
4. Before ordering any primer, undercoat and finishing paint, the Sub-Contractor shall submit the color scheme to the Employers Representative for approval.
5. Before ordering any painting materials, the Sub-Contractor shall submit the type and manufacturer of all materials for approval.
6. The Sub-Contractor shall select all finishing and painting materials from types suitable for the surfaces to which they are applied and for the environmental conditions in each area.
7. The fire services equipment shall be painted in red color with two coatings of red lead primer.

B. Plant, Machinery & Equipment

1. All items of plant, machinery and equipment supplied painted ex-factory shall be given one finishing coat of full gloss enamel, except where the manufacturer's standard finish is approved.

C. Exposed Metalwork

1. All exposed metalwork shall be wire-brushed and cleaned from rust, scale, dirt and grease, and shall then be given one priming coat, one undercoat and one approved color finishing coat of full gloss enamel.
2. The priming coat for exposed galvanized iron shall be an approved galvanized iron primer.
3. The priming coat for exposed non-ferrous metalwork shall be approved as suitable for the metal to which it will be applied.

D. Concealed Metalwork

1. All galvanized iron surface concealed in roof spaces, false ceilings, building ducts etc. shall not be painted. All black iron and steel surfaces shall be wire brushed and given one coat of zinc chromate or red lead.

C. Pipework & Metal Sheathing

1. Pipework and metal sheathing shall be painted as for exposed or concealed metalwork as applicable.
2. Turned parts of valves, controls etc., shall be cleaned and polished to approval.

D. Pipework Identification

1. All pipes etc. shall be identified in accordance with NFPA Standards or other comparable and acceptable code.
2. Circumferential bands of standard colors shall be not less than 100mm wide on pipes up to 50mm nominal diameter, and not less than 150mm wide on pipes greater than 50mm nominal diameter.

3. Supplementary colors shall be displayed as bands not less than 25mm wide in the center of the ground color bands.
4. Where lettering is required it shall be painted in contrasting colors in accordance with the standard, in block letters not less than 15mm high for pipes up to 50mm nominal diameter, and in block letter not less than 40mm high for larger pipes.
5. Identification bands shall be located where they are clearly visible in each room or compartment through which the pipe runs, and shall be placed at centers not exceeding 6m.
6. Direction of flow shall be indicated by an arrow painted on the pipe adjacent to each color band. Arrows shall be 75mm long on pipes up to 50mm nominal diameter, and 150mm long on larger pipes.

E. Colour Schemes

1. The whole of the piping installation shall be painted in accordance with the existing piping colors schemes wherever applicable and color coded as follows:

Cold water pipe	-	Green
Soft water pipe	-	Blue
Waste pipe	-	Brown
Soil pipe	-	Black
Vent pipe	-	Gray
Fire pipe	-	Red
Compressed air pipe	-	White
Vacuum pipe	-	Orange

Equipment shall be paint and color coded to BS 381C:1980 or the PSME Code as follows :

Equipment	Color	No.
Switchboard and Control Panel	Electric Orange-White Interior	
Electric Motors	Primrose	310
Electric Conduits	Light Orange	557
Pumps and tanks	As for respective piping service	-
All other equipment	As directed	-

F. Labelling

1. All plant and equipment provided under this Specification is to be labeled in English as to duty or services, all such Labelling to correspond to schedules, diagrams, etc. to be provided as part of the Record Drawings. Labels are of white Traffolyte with black engraved lettering not less than 20mm high or as otherwise required and approved.
2. Manufacturers' nameplate shall generally be provided for all plant and equipment and shall show serial and model numbers and date of manufacture.
3. All valves, motor starters, fans, distribution boards, gauges, contactors, cable terminals in switchboards, circuit breakers shall have labels.
4. Labels should be attached to valves (or pipe adjacent thereto) with a light gauge metal band or alternatively to be screwed to the insulated valve box where provided. These labels shall state the valve number.

5. Distribution boards, starters etc. shall be labeled to indicate the circuit number, phase and item controlled.
6. Labels shall be screwed or riveted to sheet metal. Adhesive fixing is not acceptable.
7. Details of exact lettering shall be agreed with the Employers Representative prior to manufacture.
8. A complete valve schedule shall be incorporated in the as-built drawings and this schedule shall clearly indicate the valve numbers, duty, function, size, flow rate and any other relevant information necessary to allow the Employer's plant operators to safely operate each valve and to subsequently maintain or replace the valve as required.
9. The valve schedule shall clearly relate to the various system schematics to enable the entire operating sequence and circuitry to be followed.

G. Application of Painting

1. All paints shall be prepared and applied in accordance with the manufacturer's recommendations.
2. All galvanized metal surfaces shall be properly etch-primed to ensure correct adhesion of the paint to the surface. Materials for etch-priming shall be as recommended by the paint manufacturers. Subsequent painting of galvanized surfaces shall comply with this Specification.
3. Prior to painting, all metallic surfaces except galvanized surfaces shall be thoroughly scraped and wire brushed as necessary to remove scale, rust and swarf. Surfaces shall then be solvent cleaned to remove all oil, grease and dirt.
4. When the surfaces to be painted are clean and dry, one coat of an approved primer shall be evenly applied over the entire area. After surfaces have been primed, the Sub-Contractor shall notify the engineers so that an inspection of the primed surfaces can be made prior to the application of the undercoat and the finishing coats.
5. When the priming coat has been approved, one coat of an approved paint flat undercoat shall be applied. Before applying the finishing coats, the Sub-Contractor shall ensure that the undercoated surface is rubbed flat and smooth. Finally, two coats of an approved high gloss finishing paint shall be applied when all dust has been removed.
6. Each successive coating shall be completely dry prior to the application of the next coat. The minimum thickness of each layer to be 50u.

3.6 TEMPORARY AND TRIAL USE

- A. Obtain written permission from Consultant to use and test permanent equipment and systems prior to Substantial Performance acceptance by Consultant.
- B. Consultant may use equipment and systems for test purposes prior to acceptance. Provide labour, fuel, material and instruments required for testing. Rectify incomplete work immediately to the satisfaction of Consultant.
- C. Protect equipment and system openings from dirt, dust and other foreign materials during temporary usage.
- D. Clean and renew equipment and systems used prior to acceptance.
- E. Warranty, including duration and commencement date, shall not to be affected by start-up date of equipment.

3.7 COMPLETION

- A. Remove all debris from inside Division 21 systems and equipment.

- B. Rectify deficiencies and complete work before submitting request for Substantial Performance inspection.
- C. Follow manufacturer's written instructions regarding bearing lubrication. Remove grease from pillowblock type bearings and install new grease before equipment is put into operation.
- D. Check and align all drives to manufacturer's acceptable tolerances.
- E. Check and align all pumps to manufacturer's acceptable tolerances.
- F. Remove all temporary protection and covers.
- G. Remove oil and grease from equipment and bases.
- H. Clean all fixtures and equipment. Polish all plated surfaces.
- I. Change air and water filters.
- J. Remove, clean and reinstall pipeline strainer screens.
- K. Leave Division 21 work in as new working order.

3.8 INSTRUCTIONS TO OWNER

- A. Submit to Owner, check lists for each system or piece of equipment, indicating that all components have been checked and are complete prior to instruction period.
- B. Thoroughly instruct the Owner in the safe and efficient operation of the systems and equipment.
- C. Arrange and pay for the services of qualified manufacturer's representatives to instruct Owner on specialised portions of the installation, such as refrigeration machines, boilers, automatic controls and water treatment.
- D. Submit a complete record of instructions given to the Owner. For each instruction period, supply the following data:
 - 1. Date
 - 2. Duration
 - 3. System or equipment involved
 - 4. Names of persons giving instructions
 - 5. Names of persons being instructed
 - 6. Other persons present
- E. Submit receipted verification of completed training to Consultant prior to final release of retentions.
- F. Carry out instructional period during a period of 5 days scheduled at Owner's convenience.
- G. Video tape all instructional sessions and turn over copy of tape to Owner upon completion of training period.

3.9 PROTECTION OF OWNER'S PREMISES

- A. Adhere strictly to the Owner's requirements.

- B. Confer with the Owner concerning schedule, dust and noise control prior to commencing work in or adjacent to existing facilities where such work might affect either those facilities or their occupants.
- C. Execute work with least possible interference or disturbance to occupants, public and normal use of premises.
- D. Provide temporary means to maintain security when security has been reduced by Division 21.
- E. Only elevators, dumbwaiters, conveyors or escalators assigned for Contractor's use may be used for moving men and material within building. Protect walls of passenger elevators, to approval of Owner prior to use. Accept liability for damage, safety of equipment and overloading of existing equipment.
- F. Provide temporary dust screens, barriers, warning signs in locations where renovations and alteration work is adjacent to areas which will be operative during work.
- G. Drawings indicate approximate locations of known existing underground and above ground facilities. Avoid damage to existing services. Bear cost of repairs and replacements.
- H. Immediately advise Consultant when unknown services are encountered and await instructions.
- I. Accept liability for costs incurred by the Owner in repairing and cleaning equipment, etc., resulting from failure to comply with the above requirements.

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PART 1 - GENERAL**1.1 WORK INCLUDED**

- A. Comply with Division 1 - General Requirements and all documents referred to therein.
- B. Provide all labour, materials, products, equipment and services to supply and install the basic mechanical materials indicated on the Drawings, specified in Division 21 of this Specifications, and where required for the proper operation of the mechanical systems.

PART 2 - PRODUCTS**2.1 INSERTS**

- A. Submit proposed materials and methods for cast-in-place inserts.
- B. Where inserts must be placed after concrete is poured, use Hilti or equivalent system.

2.2 PIPE HANGERS

- A. Provide pipe hangers and supports for all piping. Provide hangers in accordance with the following requirements. Provide galvanized steel hangers and supports for all pipework systems.
- B. Provide proprietary manufactured hangers, accessories and supports similar to the Grinnell or Myatt system or equivalent.
- C. Select products to ensure adequate safety factors under anticipated loads.
- D. Provide supports for other piping types such as plastic, mechanically fused or packed joint pipe according to the pipe manufacturers published recommendations. Support piping continuously where required to prevent sagging. Provide sway bracing to meet local seismic requirements, if any.
- E. Provide protection saddles where piping is supported from below.
- F. Provide roll type supports where shown on the drawings and where longitudinal movement may occur. Provide single pipe rolls where supported from below and where suspended. Provide spring cushions where slight vertical movement is likely and cushioning required.
- G. Provide engineering constant support hangers on piping subject to vertical movement exceeding 40 mm due to vertical pipe expansion.

2.3 EQUIPMENT RIGGING SUPPORTS

- A. Provide eyebolts suitable for block and tackle connection, adequately supported by the structure above for:
 - 1. Pumps
 - 2. Other equipment which will require block and tackle handling

2.4 SLEEVES, WALL PLATES AND FLOOR PLATES

- A. Use machine cut and reamed standard weight steel piping. Pipe sleeves 200 mm and larger shall have minimum 6 mm wall thickness.

- B. Concealed perimeter risers and runouts may have sleeves of 1.31 mm galvanized steel set to provide freedom of movement of piping. Extend 50 mm above finished floor level.
- C. For piping through exterior walls, cooperate with the waterproofing trade at all times, and do not break any waterproofing seal without consent of the waterproofing trade. Provide waterproof link seals.
- D. Provide leak plates where pipe sleeves pass through exterior building walls. Each leak plate shall be a 3.42 mm steel plate, welded to the sleeve, 100 mm diameter greater than sleeve outside diameter.
- E. Cover pipe sleeves in walls and ceilings of finished areas, other than Equipment Rooms, with satin finish stainless steel, or satin finish chrome or nickel plated brass escutcheons, with non-ferrous set screws. Do not use stamped steel split plates. Split cast plates with screw locks, however, may be used.

2.5 PROVISION FOR PIPE EXPANSION, CONTRACTION AND BUILDING SHRINKAGE

- A. Where space limitations do not permit the use of expansion loops or offsets, provide proprietary made expansion Joints properly selected for system operating pressures according to the following:
 - 1. For piping up to and including 65 mm, select ends to suit specified pipe fittings. For piping 75 mm and above, use flanged ends.
 - 2. Steel Piping - expansion joint with stainless steel pressure carrier, flanged ends.
- B. Submit for the MEEPF CONSULTANT review prior to installation, drawings showing the location of expansion joints, anchors and guides. Submit calculations to verify selection. Show details of proposed connection to structure and loads to be imposed.
- C. Recognize that the concrete structure will shrink. Provide risers with sufficient flexibility. Consult with the STRUCTURAL CONSULTANT to determine the degree of flexibility.

2.6 STRAINERS

- A. Provide pipeline strainers with stainless steel screens according to the following:

Pipe Schedule	Pipe Size	Type	Material
Copper	All sizes	Y	Bronze
Steel, cast iron, and other metal	All sizes	Y	Cast Iron or cast steel to suit system working pressure

- B. Supply one extra set of strainer screens and install after systems have been thoroughly cleaned.
- C. Equip each strainer 40 mm and smaller in size, with plugged blow off tapping.
- D. Equip each strainer 50 mm and larger in size, with blow off tapping. Provide blow off piping complete with capped shut off valve. Terminate in downward vertical position. Size blow off piping and valve the same size as the blow off tapping.
- E. Ensure that each strainer can be isolated from piping systems with isolating valves on each side of strainer, and which are not more than 3 metres away from strainer.

F. Provide strainers in the following locations:

1. at the suction/return side of each pump
2. immediately upstream of each pressure reducing valve
3. where shown on Drawings

2.7 DRAINS

- A. Provide minimum 20 mm ball valve with hose end adapter, metal cap and chain at all low points of all systems. Locate to allow easy connection of hose.
- B. Provide 20 mm valves with metal caps and chains at the base of all pipe risers. Install hose end ball valve in conjunction with 450 mm minimum length full line size dirt leg.

2.8 PRESSURE GAUGE AND TEMPERATURE GAUGE CONNECTIONS

- A. Provide pressure gauge and temperature gauge connections in the following locations:
1. on both pipe connections of fire pumps.
 2. where shown on drawings.
- B. Provide 6 mm brass needle valves at each gauge connection.

2.9 PRESSURE GAUGES

- A. Gauges shall be 113 mm size with black finish cast aluminium case, phosphor bronze Bourdon tube, brass rotary type movement, bronze bushed, silver brazed tip and socket joints, adjustable type pointer and calibrated in kPa and psi.
- B. Install each gauge with brass impulse dampener.
- C. Select gauges to suit an overpressure of 25% without damage to movement. Normal operating pressure shall indicate approximately at mid point of dial. Provide compound type gauge and scale for suction connection to pumps connected to open systems or equipment.
- D. Provide gauges with an accuracy of 1% of full scale.
- E. Provide gauges in the following locations:
1. on both pipe connections of pumps.
 2. where shown on drawings.
- F. Supply two additional gauges for each type/range as spare part and handover to the EMPLOYER'S use.

2.10 FLASHING

- A. Flashing will be carried out under each trade for roof curbs shown on their drawings.
- B. Provide flashing for pipe openings or pre-manufactured roof curbs.
- C. Carry out all counter flashing for roof mounted mechanical equipment and for pipes passing through roof. Fit counter flashing over flashing or curb. Pitch pockets are not acceptable.

2.11 CURBS

- A. Coordinate with Division 3 to provide other curbs and reinforcing steel required for Division 23.
- B. Provide roof curbs at least 200 mm above finished roof, unless exceeded by MEEPF CONSULTANT considerations.
- C. Provide concrete curbs around holes in Equipment Room floors, extending at least 150 mm above finished floor. Make watertight connection between curb and floor.
- D. Fill spaces between curbs and pipes with firestopping material. Caulk watertight with fire resistant waterproof compound.

2.12 CONCRETE

- A. Coordinate with Division 3 for provision of concrete housekeeping pads under all floor mounted mechanical equipment and supports. Extend pads over the full equipment base and isolator area.
- B. Concrete work, including housekeeping pads, required for Division 21 work and shown on the Structural or Engineering Drawings will be provided by Division 3.

2.13 STEEL

- A. Provide steel required for Division 21 work including supports, framing of openings and lintels over openings that is not shown on Structural or Engineering Drawings.
- B. Provide steel of adequate strength to support equipment and materials during all operating and test conditions.
- C. Support suspended equipment from the bottom or from manufacturer's designated suspension points. Support tanks and similar equipment with adequate beam strength by saddles with curvature to match the equipment. Continuously support other equipment.
- D. Provide base supports for all pipe risers to distribute operating and static loads to meet the MEEPF CONSULTANT requirements.
- E. Fabricate steel supports from materials having approved corrosion resistance or galvanised after fabrication.

2.14 FIRE PROTECTION EQUIPMENT SCHEDULE

- A. For full fire protection equipment schedule, please refer the technical schedules found in drawings and specifications.

PART 3 - EXECUTION**3.1 PIPE AND EQUIPMENT INSTALLATION**

- A. Locate distribution systems, equipment and materials for maximum usable space, optimum service clearances and to accommodate current requirements and identified future expansion.
- B. Coordinate Division 23 services installation above typical floor modular ceilings to allow installation and future relocation of lights and air troffers without interfering with or requiring relocation of mechanical, electrical or other services, or removal of ceiling grid.

- C. Include all pipe offsets required to eliminate interference with the work of other Divisions.
- D. Install equipment and materials to present a neat appearance. Run piping and conduit parallel to or perpendicular to building planes. Conceal piping and conduit in finished areas. Install so as to require a minimum amount of furring.
- E. Install pipe and conduit straight, parallel and close to walls and slab or deck underside, with specified pitch.
- F. Use standard fittings for all direction changes. Do not use drilled tees and other field fabricated fittings.
- G. Install eccentric reducers in horizontal piping to permit drainage and eliminate airpockets.
- H. Where pipe sizes differ from connection sizes of equipment, provide reducing fittings between inline components such as valves, strainers and fittings, and equipment. Reducing bushings are not permitted.
- I. Cap open ends of piping during installation.
- J. Use non-corrosive lubricant or teflon tape equal to Dow Corning and apply on malethread.
- K. Provide brass adapters or dielectric couplings wherever dissimilar metals are joined.
- L. No pipe to be laid in water or when, in opinion of the MEEPF CONSULTANT conditions are unsuitable.
- M. Ensure that pipe installation does not transmit vibration to the walls and floors through which they pass.
- N. Make provisions for neat finish around equipment and materials.
- O. Perform welding to meet ANSI B31.9.

3.2 CONNECTIONS TO EQUIPMENT

- A. Provide unions or flanges at all connections to equipment. Ensure that piping adjacent to equipment is readily removable for servicing and/or removal of equipment without shutting down entire system.
- B. Install unions in piping up to and including 50 mm pipe size. Install flanges in piping 65 mm pipe size and larger.
- C. Prevent galvanic corrosion by isolating copper and steel. Use red brass adapters, or completely isolate flanges using full face gaskets with bolts installed through phenolic sleeves with insulating fibre washers. Where the Code prohibits the use of red brass adapters, use insulating couplings. Where system valves are required, solid brass isolating valves may be used in lieu of adapters or couplings.
- D. Provide metallic code rated continuity link between flanges or unions, where pipe mains carry flammable fluids or gases.

3.3 INSERTS

- A. Size and space for the loads to be supported. Provide all required inserts for Division 13 system and equipment.
- B. Properly locate and firmly secure inserts to forms before concrete is poured.

- C. Place inserts only within main structure and not in any finishing materials.
- D. When inserts are required in precast concrete, supply inserts and location drawings to the precast concrete supplier for casting into material. Otherwise, include the cost of having the precast concrete supplier install inserts at the site.
- E. Do not use powder actuated tools.

3.4 HANGERS

- A. Suspend piping and equipment with all necessary hangers and supports required for a safe and neat installation. Ensure that pipes are free to expand and are graded properly. Adjust each hanger to take its full share of the weight.
- B. Suspend hanger rods directly from the structure. Do not suspend pipes or equipment from other pipes, equipment, metal work or ceilings.
- C. Provide auxiliary structural steel angles, channels and beams where piping and equipment must be suspended between joists or beams.
- D. Use galvanized rods, steel support angles, channels and beams.
- E. Space hangers to ensure that structural steel members are not over stressed. In no case shall pipe hangers be further apart than indicated in the tables. When requested, submit detailed drawings showing locations and magnitude of piping and equipment loads on the structure. Provide calculations when requested by the MEEPF CONSULTANT.
- F. Do not use trapeze type hangers for support of piping, without prior review by the MEEPF CONSULTANT. Where permitted, fabricate from angle or channel frames, and space hangers to suit the smallest pipe size.
- G. Do not use hooks, chains or straps to support equipment and materials.
- H. For precast concrete work, if inserts cannot be cast into members, pass hanger rods between the members and weld to steel plates resting on the upper surface of the precast material. To prevent raising of the hanger rod, apply a lock nut and 50 mm minimum dia. flat washer tight against the under surface of the precast material.
- I. Ensure that copper materials are completely isolated from ferrous materials. Use plastic or epoxy coated hangers and clamps, or use lead inserts between copper piping and ferrous materials, and between copper piping and copper coated ferrous materials.
- J. Provide round steel threaded rods meeting ASTM A-36.
- K. The following table establishes minimum standards of rod sizes and hanger spacing for steel, copper and plastic piping (where applicable).
 - 1. Hangers and Supports for Steel Piping
 - a. Support horizontal piping as scheduled below.

Pipe size	Maximum spacing	Hanger rod dia.
Up to 25 mm nom.dia.	2.0 Ms	8 mm (5/16 inch)
32 to 50 mm nom. dia.	3.0 Ms	10 mm (3/8 inch)
65 and 75 nom. dia.	3.6 Ms	12 mm (1/2 inch)
100 to 150 nom. dia.	4.0 Ms	16 mm (5/8 inch)
200 to 300 mm nom. dia.	4.5 Ms	20 mm (3/4 inch)
350 mm nom. dia. and over	5.0 Ms	22 mm (7/8 inch)

b. Provide pipe riser clamps / supports at every floor, for vertical piping.

2. Hangers and Supports for Copper piping

a. Support horizontal piping as scheduled below.

Pipe size	Maximum spacing	Hanger rod dia.
Up to 25 mm nom. dia.	1.8 Ms	8 mm (5/16 inch)
32 to 50 mm nom. dia.	2.4 Ms	10 mm (3/8 inch)
65 and 75 mm nom. dia.	3.0 Ms	10 mm (3/8 inch)

b. Provide riser clamps with shield 60 cm /above floor level and at branch take offs for vertical piping.

L. In addition to these basic requirements, provide hangers in the following location:

1. to eliminate vibration
2. at points of vertical and horizontal change of direction of pipe
3. at inline centrifugal pumps
4. at valves and strainers
5. on mains at branch takeoffs
6. to avoid stress on equipment connections
7. as required for seismic restraint

M. Install spring hangers or other special supports specified in Section 210548.

N. Refer to applicable articles of the Specification regarding thermal insulation requirements.

3.5 SLEEVES, WALL PLATES AND FLOOR PLATES

A. Set sleeves for piping in conjunction with erection of floors and walls. Locate sleeves accurately in accordance with submittal drawings, and as follows:

1. Through interior walls, set sleeves flush with finished surfaces on both sides.

2. Through exterior walls above grade, set sleeves flush with finished surfaces on inside and to suit flashing on outside.
 3. For floors in Mechanical Equipment Rooms, Janitors Closets, Kitchens and similar areas where a water dam is required, set sleeves flush to underside of structure and extending 50 mm above finished floor.
 4. For other floors, set sleeves flush to both finished surfaces. Refer to the Engineer's Room Finish Schedule.
- B. Size sleeves to provide 25 mm clearance around insulated piping.
- C. Ensure that fire ratings of floors and walls are maintained.
- D. Provide continuous insulation runs through fire separations. Ensure that piping do not touch sleeves.
- E. Pack clearance spaces with fire stopping materials.
- F. Install leak tight seals to meet the manufacturer's requirements. Select the inside diameter of each wall sleeve opening to fit the pipe and leak tight seal, all to ensure watertight joint.
- G. Additional sleeving requirements:
1. Provide sleeves for systems not part of the Contract, but identified to be required on the Drawings.
 2. Provide sleeves to accommodate compressed air piping and wiring conduits required for Division 23 work.
 3. Provide additional sleeves as required by the Drawings to accommodate service requirements. Include for the cost of drilling and setting sleeves.
 4. Fill unused sleeves with lime plaster.

3.6 PROVISION FOR FIRE EXPANSION, CONTRACTION AND BUILDING SHRINKAGE

- A. Make provision for pipe expansion, contraction and building shrinkage with suitable anchors and offsets or expansion loops.
- B. Install piping to allow freedom of movement in all planes without imposing undue stress on any section of main piping, branch piping, equipment and structure.
- C. When ambient temperature during installation is higher than operating temperature, use pre-compressed expansion joints.
- D. Select expansion joints to withstand system test pressure, as well as operating pressures and temperatures.
- E. Install expansion joints in accordance with manufacturer's published installation instructions.
- F. During the construction and warranty periods, regularly review provisions for building shrinkage and make necessary adjustments to piping to ensure freedom from binding and stress.

3.7 PIPE GUIDES AND ANCHORS

- A. Install pipe guides for expansion joints according to expansion joint manufacturer's published recommendations. Use at least two guides on each side of expansion joint.
- B. Install manufactured or field fabricated alignment guides to allow movement in axial direction only.
- C. Install vertical risers properly anchored and guided to maintain accurate vertical position of piping. At time of startup, clean and lubricate guides, and adjust to allow free sliding at operating conditions.
- D. For piping up to and including 75 mm, guide pipes at every floor or every 3900 mm. Guide larger pipes at every second floor or every 7500 mm.
- E. Fabricate anchors from structural steel channels, plates or angles.
- F. Secure anchors to the structure. Avoid introduction of excessive reactive forces and operating weights into the structure and onto equipment and piping.

3.8 PAINTING

- A. Supply ferrous metal work except piping with at least one factory prime coat, or paint one prime coat on job.
- B. Clean and steel brush surfaces with welds. Then prime coat all steel supports and brackets.
- C. Touch up or repaint all surfaces damaged during shipment or installation and leave ready for finish painting.
- D. Provide final coat of finish painting.

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PART 1 - GENERAL**1.1 WORK INCLUDED**

- A. Comply with the General Provisions and all documents referred to therein.
- B. Provide all labour, materials, products, equipment and services to supply and install the motors, starters, control centres and wiring indicated on the Drawings and specified in this Section of the Specification.

1.2 REGULATIONS AND STATUTORY REQUIREMENTS

- A. The entire electrical installation shall be in accordance with the regulation and requirement of all relevant authorities having jurisdiction over the installation.
- B. The requirement of NEC & PEC (National Electrical Code) shall be taken as the minimum standard for this installation.

1.3 ELECTRICITY SUPPLY

- A. The electricity supply will be 380/230 volts 60 HZ 3 phase, 4 wire. All equipment shall be designed to operate with a +10% voltage tolerance without a loss of rated output.
- B. The Electrical Sub-Contractor will provide the power supply to the systems terminating in an isolator in the following locations.
- C. The Sub-Contractor shall be responsible for extending the supply from the above mentioned isolator's and shall include all electrical works including MCB distribution boards, control panels, starter, conduits and wirings etc. necessary for the satisfactory operation of their equipment offered.

PART 2 - PRODUCTS**2.1 MOTORS**

- A. Refer to Section 210007: 60 cycle, 1750rpm motors, except where noted, with the following characteristics:
 - 1. under 0.4 kW - single phase, 230 V
 - 2. 0.4 kW and over - 3 phase, 380 V
- B. High efficiency motors shall be compatible with standard motor frames.
- C. All motors .75 kW up to and including 373 kW, unless specified differently, shall be T-frame, A.C. Three Phase and equal to or exceeding the Motor Efficiency Level as tested to the most recent issue of IEEE 112B.
- D. Provide squirrel cage induction motors built to NEMA Motor and Generator Standards.
- E. The minimum requirement for 3 phase motors shall be NEMA Design B, Class B insulated for maximum 40 deg C ambient.
- F. Select motors for quiet continuous operation to suit loads imposed by equipment. Recognize that motor horsepowers specified and scheduled are minimum sizes. Include extra costs for larger motors, starters, power wiring and additional control wiring if larger motors are required for alternative equipment accepted as part of the Contract Price.

- G. Provide motor enclosures as follows:
1. Open dripproof, 1.15 service factor for motors protected from the weather and moisture environment to operate satisfactorily at maximum temperature and moisture levels of surrounding air for motors located in air streams.
 2. Totally enclosed fan cooled 1.15 service factor for motors in all other locations, including cooling towers.
 3. Provide explosion proof motors where scheduled.
- H. Equip motors 18 kW and larger, as well as those smaller but with longer than 10 second starting time, with inherent overheat protection, consisting of thermistors, one for each phase, embedded in the stator windings. Extend wires out to motor terminal box, ready for field wiring into the starter holding coil circuit. Provide manual reset tripping device compatible with starter.

2.2 STARTERS, CONTACTORS AND MOTOR CONTROL

- A. Manufacturer may be different than other starters.
- B. Starters and contactors factory built into the control panel of packaged equipment will be considered as an integral part of the package and may be from a different manufacturer.
- C. Magnetic Motor Starters
1. Magnetic Motor Starters shall be for general purpose, Class A and for induction motors rated in horsepower.
 2. Self-contained unit in a NEMA 1 gasketed enclosure (NEMA 3R where installed outdoors), externally operable from the front.
 3. Provide full voltage non reversing (FVNR) type combination magnetic starters for motors of ½ HP to 5.0 HP.
 4. Provide reduced voltage, non-reversing, Wye-delta type combination magnetic starters for motors 7.5 HP up to 50 HP.
 - a. Adjustable timing relay for start to run transfer timing.
 - b. Closed transition from reduced to full voltage.
 5. Provide reduced voltage, non-reversing, auto-transformer type, combination starters for motors above 50 HP.
 - a. Two winding, open delta connected.
 - b. Adjustable timing relay for start to run transfer timing.
 - c. Closed transition from reduced to full voltage.
 - d. Field adjustable auto transformers taps, 50%, 65%, and 80%, factory set at 80%.
 6. Provide an individual control power transformer with two primary and one secondary control fuses for each motor controller. The other secondary lead shall be grounded. Secondary voltage shall be 230V AC.
 7. Provide each motor controller with three phase, ambient temperature compensating, thermal overload relays with heaters. Overload relays shall be adjustable from 90% to 110% of heater rating, factory set at 100%. Provide an insulated pushbutton on the outside of door to reset overload relays.
 8. Provide each motor controller with a Hand-Off-Automatic (HOA) selector switch. Provide an Hand-Automatic (HA) selector switch for life safety equipment. Mount switch on outside of door.
 9. Provide each motor controller with 2 normally open and 2 normally closed auxiliary contacts long life (50,000 hours) pilot indicators on outside of door, auxiliary relays, and other devices required for operation of the equipment to be controlled.
 10. Provide transformer type indicating lights in from cover (Lens color(s) red-stop, green run) and push to test type indicating lights.
- D. Refer to Division 26 for all other starters and contactors.

2.3 MOTOR CONTROL CENTRES

- A. Before commencing any work whatsoever on the motor control center, the Sub-Contractor shall submit drawings of the proposed layout showing all dimensions, the total weight, fixing details, cable sizes and cable termination details of both incoming and outgoing cables to the Employer's Representative for approval. Approval of drawings will be given in principle only, without abrogation of the Sub-Contractor responsibilities in respect of associated details.
- B. Control centers shall be constructed of heavy gauge sheet steel of thickness not less than 2 mm, finished in enamel of a color to the satisfaction of the Employer's Representative.
- C. Control centers shall be wall mounted and provided with hinged lockable access doors with mechanically retained gaskets and hinged top panels containing control switches, supervisory instruments and pilot light. All exterior door fittings shall be chrome plated.
- D. Control centers shall contain a main MCCB, buswork, branch switchfuses or mould case circuit breakers, motor starters, auxiliary relays, control fuses, on/off push buttons, manual/auto selector switches, duty/standby selector switches, power 'on' lights, pump running and overload lights, sump pit/water tank high/low level indications, ammeters, terminal blocks, wiring and accessories for the full operation and control of the associated pumps. All electrical equipment shall comply with the relevant section of this Specification.
- E. The Sub-Contractor shall provide voltage free dry contacts in form of terminal block inside the pump indication panel for each pump for the purpose of monitoring and logging alarm of the pumps and water tank/sump pit status. The following points for each pump/water tank/sump pit are required to be monitored:
 - 1. Pump running
 - 2. Pump trip
 - 3. Water tank low level
 - 4. Water tank high level
 - 5. Sump pit low level
 - 6. Sump pit high level

The BMS Sub-Contractor responsible for BMS work will obtain the respective signals from those indication panels only.
- F. Refer to Division 26 for motor control centres.

2.4 MOULDED CASE CIRCUIT BREAKERS

- A. All moulded case circuit breakers shall conform to IEC 157, and be of one, approved make throughout this project.

The body and base of the unit shall be moulded and the units shall be sealed after assembly.
- B. The load handling contacts shall be silver/tungsten and the contacts and operating mechanism so designed as to give a wiping action both at make and break.
- C. The breaker operating mechanism shall be of the trip-free type so designed to prevent the load handling contacts from closing on a fault.
- D. The toggle handled shall open and close all poles of a multipole circuit breaker simultaneously. A fault on one pole shall open all poles.

- E. Circuit protection against overload and fault conditions is to be provided by means of a thermal-magnetic device designed to give thermal operation on overload and magnetic operation under fault conditions. All calibration shall be made at 40°C.
- F. Positions of the breaker operating dolly are to be clearly indicated for 'ON' and 'OFF'.
- G. All MCCB shall have a breaking capacity of not less than 40KA (symmetrical).

2.5 MINIATURE CIRCUIT BREAKERS

- A. Miniature circuit breakers shall generally be similar to moulded case circuit breakers, except that the rupturing capacities shall not be less than 6KA.

2.6 CONTROL SWITCHES

- A. All control switches shall be of the rotary type.
- B. Each switch shall be panel mounted with an engraved label to clearly indicate the equipment controlled or function of the switches.
- C. Provide on-off-auto test switches, power on, green running light and red fault light for all pumps.

2.7 PILOT LIGHTS

- A. Pilot lights shall be of approved clear lamp, color dome type operated at extra low voltage. It shall be possible to change lamps from the front of the switchboard.
- B. Color of pilot lights shall be subject to the approval of the Engineer.

2.8 TERMINAL BLOCKS

- A. All terminal blocks shall be of the moulded, insulated type with individual screwed connections for each control wire terminal as Klippon or approved equivalent. Terminal shall carry numbers corresponding to the wiring diagrams.

2.9 ELECTRIC MOTORS

- A. Motors shall be manufactured in accordance with IEC 24, IEC 72.
- B. Motors shall be selected to be capable of running without overload at 20% in excess of the horsepower absorbed under normal pump duty conditions. Motors shall generally be three phases, however, small motors of 1 kW or less may be single phase.
- C. Ratings shall be based on continuous duty in the prescribed environment or an ambient temperature of 40 °C whichever is the more demanding, with an efficiency under load of not less than 0.85.
- D. Winding insulation shall be to Class F, design temperature rise Class B, unless otherwise specified.
- E. The power factor of all motors shall not be less than 0.85 lagging under all conditions.
- F. Motors up to and including 3.7 KW shall be fitted with ball bearings at both ends. Larger motors shall be fitted with roller or deep groove ball bearings. Motors operating with vertical shafts shall be equipped with bearings designed to counter unbalanced end thrust. Motors shall have a synchronous speed as shown in Equipment Schedule.

- G. Motors shall be mounted on a common bed plate with the driven machine wherever possible.
- H. Terminal boxes shall be provided for all motors and shall be of such dimensions that will ensure easy access to the terminals and allow room for the supply leads. A length of flexible conduit shall be used for connection to motor terminal boxes.
- I. Full catalogue details describing the manufacturer and model of motors selected shall be submitted with the tender documents. As far as practicable, motors shall be produced by one manufacturer.
- J. On all motors over 25 kg in weight, lifting eyes or lugs shall be supplied.

PART 3 - EXECUTION

3.1 INSTALLATION AND WIRING

- A. Provide conduit and wiring materials and methods in strict accordance with Division 26 requirements.
- B. Provide motors, starters, contactors, disconnect switches and control devices for Division 21 work.
- C. Provide all power wiring from load side of starters and contactors required for Division 21 work.
- D. Sizing for starters and wiring shall meet requirements of the Electrical Code.
- E. Provide control wiring for all equipment provided or supplied under Division 21.
- F. Install wiring materials parallel to or perpendicular to building planes.
- G. Refer to Division 26 for all line side power wiring to loose starters, MCCs and Contactors.
- H. Refer to Division 26 for normal and emergency power service locations. Provide power wiring for electrical tracing, controls and elsewhere where required.
- I. Power wiring and control wiring connected to life safety equipment shall be enclosed in Pyrotenax "MI" fire rated cable. (Wiring located in room where equipment is located shall not be fire rated).

3.2 WIRING DIAGRAMS

- A. The Sub-Contractor shall prepare construction layout and functional wiring diagrams of all switchboards, which shall be endorsed prior to commencement of any work.
- B. The wiring diagrams shall show control circuits separate from main circuits and shall indicate the size of each conductor and the color, number and/or terminal connection designation of each control conductor.
- C. Switchboard drawings shall include a schedule of all equipment mounted therein, including, make, model, and where applicable fuse rating and set point of all variable adjusters.

3.3 CABLES

- A. All wiring shall be carried out using PVC insulated stranded single core copper conductor cables to TIS 11-1988.
- B. The Sub-Contractor shall confirm loads and sizes of cables prior to placing orders.
- C. All main conductors (including neutral) shall be colored in accordance to MEA Standards for their entire length, and the phase to which they are connected. All control wiring shall be colored coded using spiral stripe tracer on base color.
- D. All PVC insulated wiring including earth wires shall be closed in conduit or approved galvanized steel trunking.
- E. To eliminate the possibility of damage to cables due to thermal expansion, allowance for movement shall be made by the introduction of a bend or set in each cable/core adjacent to the terminal.
- F. Cables shall, at all times, be handled with care and every effort made to avoid damage. They shall always be pulled from top of the drums. Care shall be exercised when breaking the rotation of the drums and under no circumstances shall cables be dragged over loose earth or concrete. Approved type of cable rollers shall be used.
- G. After installation, all cables shall be tested for continuity and insulation resistance and records of tests submitted to the Employer's Representative for approval.
- H. Single core cables shall be pulled into conduit only after the whole network, or a complete section of conduit has been installed, tested for continuity and swabbed through.
- I. The Sub-Contractor will be deemed to have allowed in his tender sum for applying sufficient lengths of cables of each type and size to complete the installation, including the due allowances for cutting and wastage.
- J. Unless specifically instructed by the Employer's Representative to the contrary, the sizes of cables employed for various types of wiring, shall not be less than the following:
 - 1. Power circuits 2.5mm²
 - 2. Earth circuits 2.5mm²
 - 3. Control circuits 1.5mm²

3.4 CONDUIT SYSTEM

- A. All conduits shall be heavy gauge galvanized welded steel complying with BS 4568:Part 1 & 2, Class 4 protection against corrosion. No conduit shall be of less than 20mm outside diameter. All conduit fittings shall comply B.S. 4568: Part II with Class 4 protection. Conduit concealed in concrete shall be so arranged as to drain naturally to outlet boxes. Sealing caps shall be placed on all conduits before concrete pouring commences to ensure no water or slurry enters the conduit. Expansion couplings shall be fitted at all building expansion joints.
- B. Surface conduits shall in no circumstances be fixed to floor slabs.
- C. All conduits systems shall be installed fully in accordance with the requirements of the I.E.E. Regulations.
- D. All conduits shall be swabbed through to clean out all dirt, burrs and moisture.
- E. All sets and bends in conduit runs shall be formed on site with bending machines. Distortion of conduits due to bending is not acceptable.

- F. Runs between draw-in boxes shall not have more than two right angle bends or their equivalent and the length of such runs shall be limited to 12 metre to permit easy draw-in cables.
- G. Flexible conduits shall be used for final connections to equipment subject to vibration or liable to withdrawal for maintenance or servicing.
- H. Flexible steel conduits and solid type adapters shall comply with B.S. 731: Part I. The conduits shall be watertight with the provision of separate earth wire enclosed for earth continuity. All flexible steel conduits shall be pvc sheathed.
- I. Bushes and plugs shall be of cast iron, galvanized. The screws for fixing the saddles shall be brass.
- J. Distance saddles shall be of cast iron, galvanized. The screws for fixing the saddles shall be brass.

3.5 CONDUIT BOXES

- A. Circular boxes, dome covers and hook covers shall be malleable cast iron, galvanized in accordance with ANSI standard. Ceiling mounted circular boxes shall have an internal depth of not less than 60mm.
- B. Adaptor boxes complete with covers shall be of cast iron, galvanized or sheet steel having Class 4 protection against corrosion. Boxes shall be not less than 50mm deep and of such dimensions as will enable the largest size cable for which the conduit run is suitable to be drawn in without excessive bending of the cables.
- C. Metal boxes for the enclosure of electrical accessories shall be 35mm deep and 47mm deep boxes shall be used to house accessories such as domestic switches, socket outlets, etc. Boxes shall have heavy duty protection against corrosion.
- D. All conduit entries to adaptor boxes, outlet boxes and switchgear shall be made with couplers and hexagonal male bushes.

3.6 TRUNKINGS

- A. Cable trunking is to be manufactured in minimum lengths of 2.5m from 1.5mm thick sheet steel finished with at least Class 2 protection against corrosion (e.g. electroplated zinc having a minimum thickness of zinc coating of 0.0025mm plus stove enamel or air drying paint). Covers shall be held in place either by spring capped trunking or by a means forming an integral part of the cover (e.g. retaining screws). Trunkings shall be terminated with end flanges bolted directly to switch or distribution boards. Connecting pieces are to be used and bolted with cadmium plated mushroom head steel screws, nuts and shake-proof washers. Each joint is to have a copper bond bolted to each adjacent trunking end to ensure electrical continuity.
- B. Conduit entries to trunking shall be made with couplings and brass male bushes. Knockouts will not be required and trunking may be drilled on site.
- C. Trunkings shall not contain more cables than allowed by the space factors described in the N.E.C.

3.7 EARTHING

- A. The network of earth electrodes and an adequately sized earth conductor will be installed by others.

- B. All metalworks associated with the electrical installation but not forming part of a live conductor, including exposed conductive parts and extraneous conductive parts, shall be solidly and effectively bonded and earthed in accordance with the latest edition of the NEC & PEC.

3.8 LOCAL SWITCHES

- A. A local switch shall be installed adjacent to each water pump motor to isolate the power supply to the motor in case of emergency or servicing.
- B. The local switch shall be watertight and able to be locked in the off position.

3.9 ELECTRICAL TESTS

- A. The precise method of carrying out the following tests shall be agreed with the Employer's Representative prior to commencement.
- B. The following items shall be tested in the sequence indicated and a complete report shall be prepared by the Sub-Contractor and submitted to the Employer's Representative for approval.
 - 1. Continuity of ring final circuit conductors
 - 2. Continuity of protective conductors
 - 3. Earth electrode resistance
 - 4. Insulation resistance
 - 5. Insulation of switchboards and distribution boards
 - 6. Functional test of control panels

3.10 MOTOR CONTROL CIRCUITS

- A. For each motor the following shall be provided:
 - 1. On-off-auto test switch
 - 2. Green pilot light
 - 3. Red fault light
 - 4. Auxiliary contacts for remote stop-start
 - 5. Auxiliary contacts for remote status indication
 - 6. Others as indicated on the drawings

Item (4) to (5) to be connected to a labelled terminal strip in the switchboard.

3.11 WARNING NOTICES

- A. Place warning notices at each starter and on or close to each motor under BMS control.
- B. Provide conspicuous notices with bold lettering and advising that the motor is under BMS control and may start at any time without warning. Submit notices at the shop drawing stage for Consultant review.

END OF SECTION

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PART 1 - GENERAL**1.1 INTENT**

- A. This section sets forth the minimum requirements for HANGERS AND SUPPORTS. This does not relieve the Architect/Engineer of the responsibility to address any portion of this section that is not included herewith.

1.2 SUMMARY

- A. This Section includes hangers and supports for mechanical system piping and equipment.

1.3 PERFORMANCE REQUIREMENTS

- A. Design channel support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

1.4 REFERENCE STANDARDS

- A. American Society for Mechanical Engineers (ASME):
B31.9 - Building Services Piping
- B. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):
MSS SP - 69 Pipe Hangers and Supports - Selection and Application
MSS SP - 89 Pipe Hangers and Supports - Fabrication and Installation Practices

1.5 SUBMITTALS

- A. Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated.

1.6 WARRANTIES

- A. All work and materials shall be warranted for one year after acceptance by the Owner.

PART 2 - PRODUCTS**2.1 MANUFACTURERS**

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to Section 210007 List of Manufacturers.

2.2 MANUFACTURED UNITS

- A. Pipe Hangers and Supports. The following is a tabulation of acceptable piping support equipment. Other manufacturers with products equal to or better than those listed will be considered.

	Material	Service	Grinnel
1	Hanger	Copper Tubing 3" and smaller	CT 65 or CT 69
2	Hanger	Steel Lines 3" and smaller	65 or 69
3	Hanger	Steel Lines 4" and larger	260
4	Hanger	Outside Insulation--All Lines	260
5	Hanger	Cast Iron Lines	260
6	Wall Bracket	All	194, 195 or 199
7	Rollers	Steel Piping	181 or 175
8	Pipe Clamps	2" and Smaller	212
9	Pipe Clamps	3" and Larger	216
10	Pipe Rest	All	192 or 259
11	Beam Clamps	All	133, 134, 218 or 292
12	Adjusters, Slides	All	439

2.3 HANGER RODS

All individually suspended horizontal pipes shall be supported by steel rods sized as follows:

	Rod Diameter	Size of Pipe or Copper Tube Supported	Size of Cast Iron Pipe Supported
1	3/8"	2-1/2" and smaller	3" and smaller
2	1/2"	3" and 4"	4" through 6"
3	5/8"	5" through 8"	8" through 10"
4	3/4"	10" and larger	12" and larger

2.4 HANGER SPACING

All horizontal lines shall be properly supported with properly spaced hangers so as to have no appreciable sagging of the lines. Hangers shall be located within 12 inches of each elbow and tee. Reference the following table for minimum spacing for copper and steel piping. If conditions or codes require, the spacing of hangers will be closer as required.

	Size of Line	Hanger Spacing in Feet
1	3/4" and smaller	5
2	1" through 1-1/2"	7
3	2" and larger	10
4	All cast iron lines	5

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger requirements are specified in Sections specifying equipment and systems.
- B. Saddles and Shields will be installed in accordance with industry standards or in accordance with manufacturer's recommendations where applicable to prevent damage to insulation.
- C. Spring Hangers and Supports shall be used as required. Due consideration shall be given to expansion and contraction, vibration and noise transmission in the design of the support system and location of individual hangers or supports.

- D. Perforated Strap Iron and Wire will under no circumstances be acceptable as hanger material.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Channel Support System Installation: Arrange for grouping of parallel runs of piping. Size and construct in accordance with manufacturer's recommendations.
- C. Heavy-duty Steel Trapeze Installation: Arrange for grouping of parallel runs of horizontal piping designed to support the combined weight of all designated lines. The spacing of trapeze supports will meet the spacing requirements of the smallest designated line or additional intermediate supports shall be added.
- D. Vertical Risers adjacent to a wall shall be supported from the wall with riser clamps sized to fit the line and adequately support their weight. There shall be a minimum of two (2) supports no more than ten (10) feet on center. The pipe shall have one support near the top of the riser. The bottom of the riser can be supported from the wall or if it runs close to the floor a pipe leg may be welded to the pipe down to and resting on the floor. The Pipe leg must terminate at the floor with a capped end.
- E. Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- F. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.
- G. Horizontal Piping Expansion: Piping subject to expansion due to temperatures above 180 degrees Fahrenheit shall be supported on roller hangers or supports sized in consideration of insulation and insulation shields.

3.3 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.
- B. Sub-base:
 - 1. All floor mounted mechanical and electrical equipment shall be mounted on a concrete sub-base not less than 4" high unless otherwise indicated. Sub-bases shall rest on structural floor.
 - 2. Electric motor shall be mounted on the same foundation as the driven machine.
 - 3. Piping connections at pumps shall be supported on the same foundation as the pumps.
 - 4. Foundation for machines shall be a minimum of 3000 psi concrete with all exposed surfaces steel trowelled smooth, reinforced with 6" x 6" No. 3 mesh. Chamfer corners of all foundations.

5. Machines shall be secured to bases with anchor bolts of ample size. All machines having bed plates and motors shall be grouted under the full area of the bed plates with a non-shrinking, premixed grout. After grout has set, all wedges, shims, and jack bolts shall be removed and the spaces filled with grout.

3.4 ADJUSTING

- A. Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

END OF SECTION

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PART 1 - GENERAL**1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Isolation pads.
 - 2. Isolation mounts.
 - 3. Restrained elastomeric isolation mounts.
 - 4. Restraining braces.

1.3 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning and Development.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic-Restraint Loading:
 - 1. Site Class as Defined in the IBC: A.
 - 2. Assigned Seismic Use Group or Building Category as Defined in the IBC: I.
 - a. Component Importance Factor: 1.5.
 - b. Component Response Modification Factor: 1.5
 - c. Component Amplification Factor: 2.5.
 - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second):
 - 4. Design Spectral Response Acceleration at 1-Second Period:

1.5 SUBMITTALS

- A. Product Data: For the following:
 - 1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
 - 2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by [an evaluation service member of ICC-ES] [an agency acceptable to authorities having jurisdiction].
 - b. Annotate to indicate application of each product submitted and compliance with requirements.

- B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional MEEPF CONSULTANT responsible for their preparation.
1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators, seismic restraints, and for designing vibration isolation bases.
 2. Seismic-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).
- C. Welding certificates.
- D. Qualification Data: For professional MEEPF CONSULTANT.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC and NFPA 13 unless requirements in this Section are more stringent.
- C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional STRUCTURAL CONSULTANT.

PART 2 - PRODUCTS

2.1 VIBRATION ISOLATORS

- A. Pads as shown on the drawing: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
1. Resilient Material: Oil- and water-resistant neoprene. Copy paragraph and subparagraphs below for each type of mount configuration required for Project. Use

drawing designation and coordinate with the Fire-Suppression Vibration-Control and Seismic-Restraint Device Schedule on Drawings.

- B. Mounts as shown: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
 - 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.
- C. Restrained Mounts as shown: All-directional mountings with seismic restraint.
 - 1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - 2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

2.2 SEISMIC-RESTRAINT DEVICES

- A. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of ICC-ES or an agency acceptable to authorities having jurisdiction.
 - 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.
- B. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.
- C. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings and matched to type and size of attachment devices used.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.
- G. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488. Minimum length of eight times diameter.

- H. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.3 FACTORY FINISHES

- A. Finish: Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
 - 1. Powder coating on springs and housings.
 - 2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
 - 3. Baked enamel or powder coat for metal components on isolators for interior use.
 - 4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Equipment Restraints:
 - 1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch (3.2 mm).
 - 2. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- B. Piping Restraints:

1. Comply with requirements in MSS SP-127 and NFPA 13.
 2. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
 3. Brace a change of direction longer than 12 feet (3.7 m).
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.
- D. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction providing required submittals for component.
- E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- F. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- G. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- H. Drilled-in Anchors:
1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the STRUCTURAL CONSULTANT if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 21 Section "Fire-Suppression Piping" for piping flexible connections.

3.5 FIRE-SUPPRESSION VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

A. Supported or Suspended Equipment: As shown on the drawing.

1. Equipment Location: As shown.
2. Pads:
 - a. Material: Neoprene.
 - b. Thickness: 40mm
 - c. Number of Pads: thick.
3. Isolator Type: Neoprene "in shear isolate".
4. Minimum Deflection: 15% of pad thickness.
5. Component Importance Factor: 1.5
6. Component Response Modification Factor: 1.5
7. Component Amplification Factor: 2.5

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PART 1 - GENERAL**1.1 WORK INCLUDED**

- A. Comply with the Agreement between the EMPLOYER'S REPRESENTATIVE and GENERAL CONTRACTOR and all other documents referred to therein.
- B. Provide all services, materials and labour required to fully commission the fire protection system in accordance with this Section of the specification.
- C. Division 21 will be responsible to carry out the commissioning requirements specified in this Sections and other sections referenced. These include, but are not limited to, commissioning, enhanced commissioning, preparation of a detailed O&M manual, and detailed training of the EMPLOYER'S personnel.

1.2 COORDINATION

- A. Meet the requirements of the General Instructions.
- B. Co-ordinate the work of this Section with all other Divisions to ensure complete and operational Fire Protection system at completion of this work.
- C. Appoint a single person as Commissioning Co-ordinator who shall be responsible for progressing the commissioning activities of each Division 21 trade.
- D. Review the design intent of the project and the intended operation of systems with the MEEPF CONSULTANT before proceeding with commissioning.

1.3 QUALITY ASSURANCE

- A. Meet NFPA Standard Guideline for Commissioning of Fire Protection System.
- B. Division may elect to source start-up and handover by a specialist commissioning company. Supply to the EMPLOYER'S REPRESENTATIVE, the following details regarding the proposed firm:
 - 1. Principal representative and qualifications
 - 2. Proposed personnel and relevant project experience
 - 3. Previous similar assignments and references
 - 4. Scope of work to be undertaken
 - 5. Company resources and equipment
- C. Use of a commissioning specialist shall not relieve Division 21 of the obligation to name one of his own employees as the person responsible for progressing commissioning, i.e. the Commissioning Co-ordinator.
- D. Supply the name, qualifications and experience of the proposed Commissioning Co-ordinator upon EMPLOYER'S REPRESENTATIVE request. Selection shall be subject to review and the approval of the MEEPF CONSULTANT. Supply alternative person(s) when requested by MEEPF CONSULTANT.
- E. The MEEPF CONSULTANT may, at his discretion, attend and advise in the commissioning process. Meet MEEPF CONSULTANT requirements.

- F. Hold and attend regular meetings during the commissioning process. Prepare detailed progress reports to coincide with regular commissioning meetings. Co-ordinate with the EMPLOYER'S REPRESENTATIVE, the preparation and issue of minutes for each meeting to be circulated to each involved trade, the MEEPF CONSULTANT and the EMPLOYER'S REPRESENTATIVE. Minutes shall highlight action items.

PART 2 - PRODUCTS

2.1 SCHEDULES AND COMPLETION OF INSTALLATION OF SYSTEMS

- A. Submit to the MEEPF CONSULTANT, 60 days prior to the scheduled Substantial Performance, a detailed and comprehensive installation completion/start-up/testing schedule, identifying all trades and suppliers to be involved. Update the schedule and resubmit for review, on a biweekly basis, during the course of commissioning. If found to be unacceptable, revise the schedule and the construction forces to suit the reviewed schedule. This schedule shall include, but is not limited to the following items:
1. Installation and testing of pipe systems
 2. Installation, leak testing and cleaning of sprinkler systems.
 3. Control system wiring (by GENERAL CONTRACTOR)
 4. Electrical service connections (by GENERAL CONTRACTOR)
 5. Equipment suppliers pre-start checkout of the equipment installations, including controls.
 6. Start-up of various pieces of equipment and systems
 7. Operational testing of system components
 8. Performance testing of equipment and systems
 9. Acceptance testing of equipment installations and system including fire and sprinkler systems, by authorities having jurisdiction and EMPLOYER'S insurance company
 10. Troubleshooting
 11. Calibration of controls and point checkout (by GENERAL CONTRACTOR)
 12. Control software set-up and checkout including seasonal and response checkout of operating sequences, PID optimisation (by GENERAL CONTRACTOR).
 13. Emergency system checkout
 14. Fire alarm and control system interfacing (by GENERAL CONTRACTOR & Division 26)
 15. Submittal of completed equipment and system checkout sheets
 16. Demonstration of systems and equipment
 17. Maintenance manual preparation and submittal
 18. Operator training program

19. Record documentation submittal

2.2 RECORD DOCUMENTATION

- A. Prepare record documentation for each equipment installation covering:
1. Equipment identification and supplier
 2. Shop Drawing submittal, review, production release, and delivery dates
 3. Dates for completion of all work required to prepare for equipment installation
 4. Dates for equipment installation, supplier pre-start checkout and system availability for start-up
 5. Dates for equipment start-up, performance testing, proposal for temporary use, acceptance testing, demonstration, turnover and warrantystart/finish
- B. Submit proposed record sheets and procedures to MEEPF CONSULTANT for review, when requested by the EMPLOYER.
- C. List all specialist personnel and equipment required for the test and ensure that these are available by the test date.
- D. Provide documentation of the commissioning process for inclusion into the maintenance manuals. These are to include checkout sheets, equipment data sheets, start-up certificates from suppliers involved in start-up, documentation concerning demonstration to the EMPLOYER. Include all record and result sheets form commissioning tests.
- E. Maintain a log of key operating parameters, problems encountered, solutions employed and verification of effectiveness of solutions. Include log in maintenance manuals.
- F. Refer to example documentation available from EMPLOYER'S REPRESENTATIVE. Meet or exceed this level of reporting.

2.3 START-UP

- A. Co-ordinate and supervise the start-up of the various pieces of equipment and systems. Utilize the start-up services of the manufacturer's representative. Ensure that the equipment is operating in a satisfactory manner. Check the following items:
1. Direction of rotation
 2. Grease and lubricants
 3. Noise, if deemed to be a problem
 4. Seals
 5. Alignment of pump and fan drives by a millwright
 6. Piping connections and safeties
 7. Electrical amp draw, starting inrush current and trip/heater settings
- B. Meet Section 230010 requirements for Temporary Services and Temporary and Trial Use.

2.4 TROUBLESHOOTING

- A. Resolve inter Division co-ordination problems.
- B. Where problems become apparent during the commissioning process, identify and resolve these problems. The basic functions in troubleshooting are:
 - 1. What - identification and definition of the problem
 - 2. Why - determination and evaluation of the causes
 - 3. When - determine the time available to resolve the problem
 - 4. Involve the designing authority in the review of the problem and proposed resolution.
 - 5. Co-ordinate remedial action with the appropriate parties
 - 6. Evaluate the effectiveness of the remedial action
 - 7. Record the problem, cause, remedial action and result

2.5 OPERATION AND TESTING

- A. Meet Section 230010 requirements for Inspection, Testing and Certificates.
- B. Test the operation of the individual components and systems. Go through each step of the sequence of operation and verify that each component operates correctly. Direct and ensure that all trades involved make the required changes and adjustments to effect the proper operation of all components and systems. Meet commissioning test requirements.
- C. Document operation and testing.
- D. Carry out operational tests for the current season and simulate operation of summer and intermediate seasons.

2.6 DEMONSTRATION

- A. Demonstrate the proper operation of all equipment and systems supplied under this Division. Demonstrations shall occur only after the operation and testing has been successfully completed. Ensure that GENERAL CONTRACTOR and equipment suppliers participate in the demonstration as required.
- B. Meet requirements for Instruction to EMPLOYERS.
- C. Engage a factory-authorized service representative to train EMPLOYER'S maintenance personnel to adjust, operate, and maintain wet pipe sprinkler system. Refer to Section 210800 "Commissioning." Provide video recording of all training sessions.

2.7 OPERATING AND MAINTENANCE MANUALS

- A. Meet Section 230010 requirements.
- B. Co-ordinate the manual provision with MEEPF CONSULTANT prepared Operation and Maintenance Manual, if available.

2.8 RECORD DRAWINGS

- A. Meet Section 230010 requirements.

2.9 COMPLETION

- A. Meet Section 230010 requirements.

2.10 SPARE PARTS

- A. Provide a list of spare parts, special tools, lubricants, etc. for each item of equipment which has been purchased as part of the Contract.
- B. Provide a listing of recommended spare parts for all equipment installed under Division 21, to cover a period from Substantial Completion to Warrantyend.
- C. Provide at minimum, the following information for recommended spare parts:
 - 1. Manufacturer's name, address, phone and fax numbers
 - 2. Manufacturer's part name, part number, unit price, lead time, shelf life
 - 3. Quantity recommended for 1 year
 - 4. Alternative suppliers of compatible parts, including local supplier name, address, phone and fax numbers
- D. Submit preliminary list of spare parts and tools to EMPLOYER at least 30 days prior to intended system handover to EMPLOYER. The EMPLOYER reserves the right to add to, reduce or omit entirely, the recommendations contained on these lists.

PART 3 - EXECUTION**3.1 COMMISSIONING TESTS**

Fire Protection System:

- A. Verify readings, calibration and set-up of sensors and equipment, including:
 - 1. Water flow sensors
 - 2. Flow switches
 - 3. Status switches (supervisory switches)
 - 4. Pressure gauges and gauge connection utilization
 - 5. Alarm contacts
- B. Verify correct sensors are reporting accurately to the distributed field panels and operator workstation.
- C. Operate each pump. Verify and correct the following if required:
 - 1. Start/stop from the terminal
 - 2. Stable operation of controls under normal conditions and with changes in water pressure /on/off conditions
 - 3. Trend logs operation indication

- 4. Piping, sensor and unit installation
- 5. Pump sequencing, flow rates and pressure (as per NFPA)
- D. Verify systems pipe cleaning and chemical treatment condition for all systems.
- E. Verify access to all valves, equipment and components for servicing.
- F. Verify control valve operation.

Other Services:

- A. Co-ordinate with Division 26, a power failure test with emergency generator start-up.
 - 1. Miscellaneous equipment on emergency power, with Division 26.
 - 2. Stability of control equipment with start-up power surge
 - 3. Controls system recovery
- B. Verify the operation of all other equipment provided by Division 21.
- C. Verify that interfacing to the work of other Divisions results in complete and operational systems.

3.2 POST SUBSTANTIAL PERFORMANCE VISITS

- A. Visit the site and the EMPLOYER'S REPRESENTATIVE each month after Substantial Performance for a minimum period of two days until the end of the project warranty period.
- B. Review the operation of the system.
- C. Correct any operating problems, if problem is related to warranty issues.
- D. Prepare a report for the MEEPF CONSULTANT and EMPLOYER'S REPRESENTATIVE for inclusion in the Operating Manuals of the problems and issues that have arisen and the corrective action(s) recommended and implement.
- E. Participate in the Deferred Testing defined in Section 210800.

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PART 1 - GENERAL**1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Fire protection cabinets for the following:
 - a. Portable fire extinguishers.
 - b. Fire hose valves.
 - c. Fire hoses and racks.
- B. Related Sections:
 - 1. Division 9 painting Sections for field painting fire protection cabinets.
 - 2. Division 10 Section "Signs" for directional signage to out-of-sight fire extinguishers and cabinets.
 - 3. Division 10 Section "Fire Extinguishers."
 - 4. Division 21 Section "Fire-Suppression Piping" for hose systems, racks, and valves.
 - 5. Division 26 Sections for Low-voltage wiring for fire protection cabinet alarms.
 - 6. Division 26 Section "Interior Lighting" for fire extinguisher location lights.

1.3 UNIT PRICES

- A. Work of this Section is affected by USD and Peso

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire protection cabinets.
 - 1. Fire Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.
 - 2. Show location of knockouts for hose valves.
- B. Shop Drawings: For fire protection cabinets. Include plans, elevations, sections, details, and attachments to other work.
- C. Samples for Initial Selection: For each type of fire protection cabinet indicated.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
 - 1. Size: 6 by 6 inches (150 by 200 x 400mm) square.
- E. Product Schedule: For fire protection cabinets. Coordinate final fire protection cabinet schedule with fire extinguisher schedule to ensure proper fit and function.

F. Remaining paragraph is defined in Division 1 Section "Submittal Procedures" as an "Informational Submittal."

G. Maintenance Data: For fire protection cabinets to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Fire-Rated, Fire Protection Cabinets: Listed and labeled to comply with requirements in ASTM E 814 for fire-resistance rating of walls where they are installed.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Preinstallation Conference: Conduct conference at Net Lima Building, Taguig City.

1. Review methods and procedures related to fire protection cabinets including, but not limited to, the following:

a. Schedules and coordination requirements.

1.6 COORDINATION

A. Coordinate size of fire protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.

B. Coordinate size of fire protection cabinets to ensure that type and capacity of fire hoses, hose valves, and hose racks indicated are accommodated.

C. Coordinate sizes and locations of fire protection cabinets with wall depths.

1.7 SEQUENCING

A. Apply decals vinyl lettering powdered coated painting for fire protection cabinets final color is used on architectural wall finishes.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.

B. Aluminum: Alloy and temper recommended by aluminum producer and manufacturer for type of use and finish indicated, and as follows:

1. Sheet: ASTM B 209 (ASTM B 209M).
2. Extruded Shapes: ASTM B 221 (ASTM B 221M).

C. Stainless-Steel Sheet: ASTM A 666, Type 304.

D. Copper-Alloy Brass Sheet: ASTM B 36/B 36M, alloy UNS No. C26000 (cartridge brass, 70 percent copper).

E. Copper-Alloy Bronze Sheet: ASTM B 36/B 36M, alloy UNS No. C28000 (muntz metal, 60 percent copper).

F. Clear Float Glass: ASTM C 1036, Type I, Class 1, Quality q3, 3 mm thick.

- G. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, and 3 mm thick, [Class 1 (clear).
- H. Break Glass: Clear annealed float glass, ASTM C 1036, Type I, Class 1, Quality q3, 1.5 mm thick, single strength.
- I. Tempered Break Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 1.5 mm thick.
- J. Wire Glass: ASTM C 1036, Type II, Class 1, Form 1, Quality q8, Mesh m1 (diamond), 6 mm thick.
- K. Transparent Acrylic Sheet: ASTM D 4802, Category A-1 (cell-cast sheet), 1.5 thick, with (patterned, textured).
- L. Acrylic Bubble: One piece.

2.2 FIRE PROTECTION CABINET (RECESSED MOUNTED TO FIRE RATED WALL)

- A. Cabinet Type: Suitable for fire (recessed to fire rated wall) hose, rack, valve, extinguisher and spanner wrench.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to Section 210007.
- B. Cabinet Construction: 2-hour fire rated.
 - 1. Fire-Rated Cabinets: Construct fire-rated cabinets with double walls fabricated from 0.0428-inch- (1.1-mm-) thick, cold-rolled steel sheet lined with minimum 5/8-inch- (16-mm-) thick, fire-barrier material. Provide factory-drilled mounting holes.
- C. Cabinet Material: Steel sheet or any material complying to 2 hours fire rating requirement.
 - 1. Shelf: Same metal and finish as cabinet.
- D. Recessed Cabinet: Cabinet box recessed in walls of sufficient depth to suit style of trim indicated.
 - 1. Trimless with Concealed Flange: Surface of surrounding wall finishes flush with exterior finished surface of cabinet frame and door, without overlapping trim attached to cabinet. Provide recessed flange, of same material as box, attached to box to act as plaster stop.
 - 2. Trimless with Hidden Flange: Flange of same metal and finish as box overlaps surrounding wall finish and is concealed from view by an overlapping door.
 - 3. Exposed Flat Trim: One-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
- E. Cabinet Trim Material: Same material and finish as door or approved manufacturing standard.
- F. Door Material: Copper-alloy bronze sheet or approved manufacturer standard.
- G. Door Style: Fully glazed, frameless, backless, acrylic panel Fully glazed panel with frame] or approved manufacturer standard.
- H. Door Glazing: Clear float glass or approved manufacturer standard complying to fire rating requirement.

1. Acrylic Sheet Color: Clear Bronze transparent acrylic sheet.
 2. Acrylic Sheet Color: Clear transparent acrylic sheet painted white red black on unexposed side.
 3. Acrylic Bubble Color: Clear Bronze Red, transparent.
- I. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
1. Provide projecting door pull and friction latch manufacturer's standard.
 2. Provide concealed hinge manufacturer's standard hinge permitting door to open 180 degrees.
- J. Accessories:
1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
 2. Break-Glass Strike: Manufacturer's standard metal strike, complete with chain and mounting clip, secured to cabinet.
 3. Lettered Door Handle: One-piece, cast-iron door handle with the word "FIRE" embossed into face.
 4. Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle or manufacturer standard.
 5. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated as directed by ARCHITECT.
 - a. Identify fire extinguisher in fire protection cabinet with the words "FIRE EXTINGUISHER." 10 lbs. CO₂/Dry Chem
 - 1) Location: Applied to location indicated on Drawings.
 - 2) Application Process: Pressure-sensitive vinyl letters.
 - 3) Lettering Color: Red.
 - 4) Orientation: As indicated on Drawings.
- K. Finishes:
1. Manufacturer's standard baked-enamel paint for the following:
 - a. Exterior of cabinet door, and trim except for those surfaces indicated to receive another finish.
 - b. Interior of cabinet and door.
 2. Aluminum: Powder coated color subject for approval by ARCHITECT.
 3. Steel: Powder coat
 4. Copper Alloy, Brass: Manufacturer Standard
 5. Copper Alloy, Bronze: Manufacturer Standard

2.3 FIRE PROTECTION CABINET (SURFACE MOUNTED)

- A. Cabinet Type: Suitable for fire hose, rack, valve, and extinguisher.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include.
- B. Cabinet Construction: Nonrated Locally fabricated.
- C. Cabinet Material: (1.7-mm-) thick steel.

1. Shelf: Same metal and finish as cabinet.
- D. Surface-Mounted Cabinet: Cabinet box fully exposed and mounted directly on wall; with no trim. Provide where walls are of insufficient depth for semi recessed cabinet installation.
- E. Cabinet Trim Material: Steel sheet.
- F. Door Material: 0.0966-inch- (2.5-mm-) thick steel.
- G. Door Style: Solid opaque panel with frame.
- H. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated, and as follows:
 1. Recessed door pull.
 2. Continuous Hinge: Same material and finish as trim, permitting door to open 180 degrees.
 3. Mechanical Deadlock: Lockbolt retracted and extended by five-tumbler cylinder; keyed one side.
 - a. Lockbolt: 1-1/2 inches high by 3/4 inch (38 mm high by 19 mm) thick; 5/8-inch (16-mm) throw.
 4. Mechanical Deadlock: As specified in Division 8 Section "Detention Door Hardware."
 5. Mechanical Snaplatch: Automatic snaplatch when closed; latchbolt retracted by five-tumbler cylinder; keyed one side.
 - a. Lockbolt: 1 inch high by 7/16 inch (25 mm high by 11 mm) thick; 5/16-inch (8-mm) throw.
 6. Mechanical Snaplatch: As specified in Division 8 Section "Detention Door Hardware."
- I. Accessories:
 1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to security fire protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.
 2. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location as indicated on the plan.
 - a. Identify fire extinguisher in security fire protection cabinet with the words "FIRE EXTINGUISHER".
 - 1) Location: Applied to location indicated on Drawings.
 - 2) Application Process: Pressure-sensitive vinyl letters.
 - 3) Lettering Color: Red.
 - 4) Orientation: As indicated on Drawings.
 3. Keys to Door Locks: Three per lock.
- J. Finishes:
 1. Manufacturer's standard baked-enamel paint for the following:
 - a. Exterior of cabinet door surfaces indicated to receive another finish.
 - b. Interior of cabinet and door.

2. Steel:
3. Steel Sheets: Powdered coated

2.4 FABRICATION

- A. Fire Protection Cabinets: Provide manufacturer's standard box (tub) with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
 1. Weld joints and grind smooth.
 2. Provide factory-drilled mounting holes.
 3. Prepare doors and frames to receive locks.
 4. Install door locks at factory.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.
 1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch (13 mm) thick.
 2. Fabricate door frames of one-piece construction with edges flanged.
 3. Miter and weld perimeter door frames.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for hose valves racks and cabinets to verify actual locations of piping connections before cabinet installation.
- B. Examine walls and partitions for suitable framing depth and blocking where recessed and surface mounted cabinets will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare recesses for recessed and surface fire protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

- A. General: Install fire protection cabinets in locations and at mounting heights indicated at heights acceptable to authorities having jurisdiction.
 1. Fire Protection Cabinets: as indicated on detailed drawings.
- B. Fire Protection Cabinets: Fasten cabinets to structure, square and plumb.
 1. Unless otherwise indicated, provide recessed fire protection cabinets. If wall thickness is not adequate for recessed cabinets, provide semi recessed fire protection cabinets.
 2. Provide inside latch and lock for break-glass panels.
 3. Fasten mounting brackets to inside surface of fire protection cabinets, square and plumb.
 4. Fire-Rated, Hose and Valve Hose-Valve Cabinets:

- a. Install cabinet with not more than 1/16-inch (1.6-mm) tolerance between pipe OD and knockout OD. Center pipe within knockout.
 - b. Seal through penetrations with firestopping sealant as specified in Division 7 Section "Through-Penetration Firestop Systems"
- C. Identification: Apply decals vinyl lettering at locations indicated.

3.4 ADJUSTING AND CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as fire protection cabinets are installed unless otherwise indicated in manufacturer's written installation instructions.
- B. Adjust fire protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
- C. On completion of fire protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
- D. Touch up marred finishes, or replace fire protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire protection cabinet and mounting bracket manufacturers.
- E. Replace fire protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

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PART 1 – GENERAL**1.1 DESCRIPTION**

- A. Comply with Division 1- General Requirements and all documents referred to therein.
- B. Provide all labor, material, equipment and appliances, and perform all operations for the work as outlined in the specifications and delineated on the Drawings for the installation of complete combined Fire Standpipe and Sprinkler System. All work shall be performed in strict accordance with these specifications and the Drawings. Secure and pay FOR TENDERS, fees and inspections required for the approval of Fire Standpipe and Sprinkler systems. Perform hydraulic calculations, and file the shop drawings and the calculations with Factory Mutual and the Building Authorities.
- C. GENERAL CONTRACTOR for this work shall be held to have read all of the tender requirements, the General Conditions, and in the execution of work he will be bound by all of the conditions and requirements therein.
- D. Following is a brief outline and description of the work included, but shall not be considered as complete and all inclusive:
 - 1. Pipe and Fittings
 - 2. Joints
 - 3. Hangers and Supports
 - 4. Pipe Sleeves
 - 5. Valves
 - 6. Fire Department Connections and Auto Ball Drips
 - 7. Sprinkler Cabinets
 - 8. Identification Tags
 - 9. Tests
 - 10. Sprinkler Heads
 - 11. Water flow Switches
 - 12. Fire Extinguishers
 - 13. Pressure Alarm Switches (for Dry Pipe Valves)
 - 14. Double Interlocked Pre-action Valves
 - 15. Tamper Switches
 - 16. Fire Pumps and Jockey Pumps.
- E. Hazard classification
 - 1. Light Hazard:
 - a. Offices, Corridor and Fire command centre .

2. Ordinary Hazard Group 1:

a. Parking Garage

F. Related Documents

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

1.2 RELATED SECTIONS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Division 21 will be responsible to carry out the commissioning requirements specified in this sections and other sections referenced. These include, but are not limited to, commissioning, enhanced commissioning, preparation of a detailed O&M manual, and detailed training of the EMPLOYER'S personnel.

1.3 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure not exceeding 175 psig (1206 kPa).
- B. High-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure higher than standard 175 psig (1206 kPa), but not higher than 500 psig (3450 kPa).

1.4 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.
- B. Deluge Sprinkler System: Open sprinklers are attached to piping connected to water supply through deluge valve. Fire-detection system, in same area as sprinklers, opens valve. Water flows into piping system and discharges from attached sprinklers when valve opens.

1.5 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure.
- B. High-Pressure Piping System Component: Listed for 350 psig (2413 kPa) and MSS-SP- 70, 71, type 1 and 110 for 500 psig (3450 kPa) working pressure.
- C. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional MEEPF CONSULTANT, using performance requirements and design criteria indicated.

1. Available fire-hose valve flow test records indicate the following conditions:

- a. Date:
- b. Time:
- c. Performed by:
- d. Location of Residual Fire Hose Valve
- e. Location of Flow Fire Hose Valve

- f. Static Pressure at Residual Fire Hose Valve
 - g. Measured Flow at Flow Fire Hose Valve
 - h. Residual Pressure at Residual Fire Hose Valve
- D. Sprinkler system design shall be approved by authorities having jurisdiction.
 - 1. Margin of Safety for Available Water Flow and Pressure: 20 percent, including losses through water-service piping, valves, and backflow preventers.
 - 2. Sprinkler Occupancy Hazard Classifications:
 - a. Automobile Parking Areas and Retail Area Mechanical Room: Ordinary Hazard

1.6 QUALITY ASSURANCE

- A. All materials and equipment shall be produced in a plant of recognized reputation and regularly engaged in the production of pipes and/or equipment conforming to the specified standards. A single manufacturer shall produce all the pipe of the same type supplied for the work. Materials and equipment shall be new, of makes and kinds specified herein, or as indicated on the Drawings, without exception.
- B. All material and work to be in accordance with applicable portions of the latest revisions and editions of the following standards unless otherwise indicated.
 - 1. NFPA 13 Standard for the Installation of Sprinkler Systems
 - 2. NFPA 14 Standard for the Installation of Standpipe and Hose Systems
 - 3. NFPA 20 Standard for the Installation of Stationary Fire Pumps for Fire Protection
 - 4. NFPA 72 National Fire Alarm Code
 - 5. ASTM American Society for Testing Materials
 - 6. ANSI American National Standards Institute
 - 7. AWWA American Water Works Association
 - 8. UL Underwriters Laboratories Inc.
 - 9. FM Factory Mutual
 - 10. IBC International Building Code 2003
 - 11. IFC 2003 International Fire Code
 - 12. NFPA 10 Standard for Portable Fire Extinguishers
 - 13. NFPA 22 Standard for Water Tanks for Private Fire Protection
 - 14. Local Codes and Regulations
 - 15. FM Global Data Sheets
- C. All equipment shall be UL-listed and FM approved.
- D. The complete fire protection installation shall be made by an approved installer, specializing in sprinkler and fire protection work, having not less than five (5) years experience in installing systems of comparable size.

- E. GENERAL CONTRACTOR shall submit proof of valid license to perform work in the Philippines.
- F. If any of the requirements of the above are in conflict with one another or with the requirements of these specifications, the most stringent requirement shall govern.

PART 2 – PRODUCTS

2.1 PIPE FITTINGS

A. Pipe

- 1. B.I. Pipes, Schedule 40 as indicated, conforming to the latest standard specification for welded steel pipe of the ASTM A-53 and ASTM A-135 (ERW).
- 2. Provide schedule 40 ERW pipe for 150mm pipe for express riser supplying from Fire Pump Room up to penthouse.
- 3. Provide piping, 50 mm smaller: black steel pipe ASTM A53/ASTM A-135 (ERW) schedule 40 with black cast-iron, malleable iron threaded

B. Fittings

- 1. Sizes 50 mm and smaller: Cast steel or malleable iron fittings, 3,000 kPa. Cast iron may be used for drain pipe fittings.
- 2. Sizes 65 mm and larger: Victaulic grooved 07 Zeroflex (3,240 kPa), Firelock (3,280 kPa), or ductile iron ASTM A-536.
- 3. Malleable or ductile iron fittings class 300 lbs. Shall be used except fittings for the offices express riser that should be class 600 lbs schedule 80.
- 4. Branch outlets shall be Victaulic style 920, 921, 925 or 929 mechanical T-branch connections, with Grade "E" standard pressure resilient gasket (Grade "E" O-Ring for Style 925).
- 5. Fittings and couplings for galvanized pipe shall be galvanized.
- 6. All couplings and fittings shall be provided by a single source supplier.

2.2 VALVES

A. Gate Valves

- 1. UL approved, FM approved, bronze body, OS&Y, rising stem, flanged ends, 3,450 kPa.
- 2. Valves 50 mm and smaller, bronze to ASTM B61 solid wedge and screw ends. O, S & Y
- 3. Valves 65mm and larger, Iron body bronze, O, S & Y Solid wedge, Flange ends, 1400 kPa w.o.g except for residential express riser and fire pump valve assembly that should be 3240 kPa w.o.g.

B. Check Valves

- 1. UL approved, FM approved
- 2. Valve 50mm and smaller, bronze to ASTM B61 designed for both horizontal vertical mounting replaceable composition disc and seat ring, screwed cap and end, 1400 kPa w.o.g.

3. Valves 65mm and larger, iron body, UL, FM approved, MSI AWWA bronze disc and seat ring, bolted cap to either horizontal or vertical mounting, flange ends 3413 kPa w.o.g except for residential express riser that should be 3240 kPa w.o.g.
- C. Butterfly Valves
 1. UL-listed and FM approved, indicating type with supervisory monitoring switches, ductile iron body.
- D. Provide tamper switches for all valves controlling flow in fire sprinkler systems.
- E. Tamper switches to be installed and adjusted by GENERAL CONTRACTOR.
- F. Provide valve bypass on valves 150 mm and larger. Pressure rating of bypass valve shall be equal to the pressure of the main valve.
- G. Provide 300 mm wide wrought iron or steel ladder for valves with operating mechanism located more than 2 m above a floor or landing.

2.3 FIRE DEPARTMENT CONNECTION

- A. All Fire Department Connections (FDC) shall be equipped with a single 100 mm “HYDRA STORZ” quick-connect fitting with a 30-degree down angle and suite to couplings of local fire brigade department.
- B. Words “Sprinkler and hydrant” cast-in on escutcheon.

2.4 AUTO BALL DRIP

- A. 20 mm bronze with both ends threaded.
- B. Install in horizontal position, pipe to spill over floor drain.

2.5 DRAINS

- A. Provide valves and/or plugs at base of risers and other locations required for complete drainage of system.

2.5 PRESSURE REDUCING VALVES

- A. Provide angle globe pattern, single seated, hydraulically operated, pilot controlled, diaphragm type, normally open valve of cast iron construction with flanged ends.
- B. The valve trim and pilot assembly shall be stainless steel and pressure setting shall be made with a single screw, housed in a screwed-on sealable housing. Wetted areas of the valve body shall be epoxy coated. The assembly shall be complete with shut-off valves, strainer, pressure gauges, size adjustment spools etc.
- C. The valve shall be UL-listed for fire protection services.

2.6 HANGERS AND SUPPORTS

- A. Hangers and supports shall be provided and installed for all piping as required by this specification and all authorities having jurisdiction over the work, and shall be approved by the MEEPF CONSULTANT. Support piping independently from structure.
- B. All hangers and supports shall be made of steel or other durable and non-combustible materials. Wood, wire, or perforated strap iron shall not be used as permanent hangers or supports. Hangers that penetrate finished ceilings shall be provided with a chrome or nickel plated escutcheon plate manufactured by Grinnell, or approved equal.

- C. Hangers and supports shall be installed so as not to interfere with the free expansion and contraction of piping, and all nuts and bolts shall be drawn up tight.
- D. Except where specified elsewhere, hangers for pipes shall be adjustable wrought steel, clevis type, similar to Grinnell Figure No. 260, or approved equal. Hangers shall be complete with bolts, rod and two nuts for each bolt. The diameter of hanger rods shall be as follows:

<u>Pipe Size</u>	<u>Diameter of Rod</u>
20 mm – 50 mm	10 mm
65 mm – 85 mm	13 mm
100 mm – 125 mm	16 mm
150 mm	20 mm

- E. Small tubing to gauges, controls, or other equipment installed on any apparatus shall be secured in place with bolted clips.
- F. All vertical piping shall be firmly supported by riser clamps properly installed to relieve weight from fittings and piping at base of risers. Vertical pipes shall have riser clamps not to exceed 4.5 m spacing.
- G. Where required, furnish and install heavy anchorage to the pipe against movement from expansion and contraction and secure the approval of the MEEPF CONSULTANT for the method of installing the anchorage before the work.
- H. Horizontal piping shall be supported at intervals not greater than 3 m spacing and at all changes of direction.
- I. Where static pressure exceeds 650 kPa, provide support to prevent upward movement at the end of branch lines and arm-overs where sprinklers are below ceilings, where required by NFPA 13.

2.7 PIPE SLEEVES

- A. Furnish, install and be responsible for the location of proper sleeves for all pipes passing through floor, walls, partitions or other building construction. Where sleeves occur in concrete construction, they shall be set before concrete is poured.

Set sleeves and anchors in a suitable manner so that they will not become displaced. Sleeves for piping passing through walls and floors in concealed spaces shall be cut flush with walls or floor. All sleeves shall be Schedule 40 galvanized steel pipe, and of such a size as to permit piping and piping insulation to pass through sleeve.

- B. Sleeves passing through foundation walls or exterior walls, or where seepage may occur, shall be thoroughly waterproofed by removing all loose material and caulking with oakum and lead wool tightly around pipe or exterior as well as interior surface. Finish off interior surface with cement. Finish off exterior surface with two layers of felt, mopped on with hot asphalt, making for an absolutely waterproof installation. All waterproofing must be performed before any backfilling is done.

- C. On all pipes passing through fire rated walls and ceilings, in finished areas, and where pipes are exposed to view, furnish and install plates on each side of the wall, Grinnell No. 13 chrome- or nickel-plated, or approved equal. Plate shall be large enough to cover sleeve opening and pass insulation. Clamp plate firmly to pipe by means of setscrews.
- D. Sleeves passing through walls and floors between rooms shall be filled from both ends of sleeve with fireproof insulation material of a fire rating equal to that of the wall or floor.

2.8 ALARM SWITCHES

- A. Provide paddle type alarm switches for wet pipe systems. Provide Alarm Pressure Switches for dry-pipe systems.
- B. Water flow alarm switches shall be UL listed Reliable Model A or similar with pneumatic retard mechanism.
- C. Provide flow detection and valve closed interface with the Fire Alarm System.

2.9 FLOOR CONTROL VALVE ASSEMBLY

- A. Prefabricated, UL-listed and FM approved assembly consisting of a grooved end body, flow switch, inspectors test valve and pressure gauge.
- B. Provide a check valve at each connection to the riser.
- C. Provide check valve at drain before connection to drain riser.
- D. Provide flow detection and valve closed interface with the Fire Alarm System.

2.10 IDENTIFICATION

- A. Signs, charts and tags shall be provided as described in NFPA 13 (Standard for the Installation of Sprinkler Systems).
- B. Painting finish (type, quality, and colour) to all fire protection pipework shall comply with the requirements of Local Code Authority.
- C. All equipment shall have a nameplate that identifies the manufacturer's name, address, type or style, model or serial number, and catalog number.

2.11 SPRINKLER

- A. All sprinklers shall be UL listed and FM approved of automatic glass bulb type, standard orifice (15 mm) color coded as follows:
 - 1. 57 deg. C Orange
 - 2. 68 deg. C Red
 - 3. 79 deg. C Yellow.
 - 4. 93 deg. C Green.
- B. Air-conditioned areas with false ceiling:
 - 1. Factory painted brass, spray type, rated 68 deg. C, installed pendant with matching ceiling plates.
 - a. Ref: Viking, Tyco or approved equal.

2. Air-conditioned Plant Rooms: Brass construction, conventional type, rated 68 deg. C, installed upright or pendant as appropriate.
 - a. Ref: Tyco, Viking, Central, Reliable
3. Non air-conditioned Plant Rooms and other Areas: Brass construction, conventional type, rated 74 deg. C, installed upright or pendant as appropriate.
 - a. Ref: Tyco, Viking, Central, Reliable
4. Through wall sprinklers (conditioned areas): Chrome plated brass, rated 68oC complete with sleeved escutcheon.
 - a. Ref: Viking, Tyco, Central, Reliable
5. Side wall sprinklers (Non-conditioned areas): Chrome plated brass, rated 74 deg. C installed upright.
6. Concealed sprinklers: 0.3mm frangible glass bulb type, standard orifice (15mm/1/2 inch), rated 57 deg. C complete with cover plate.

2.12 SPRINKLER CABINETS

- A. Provide spare sprinkler emergency cabinet and spare stock of sprinklers heads conforming to NFPA 13 (Standard for the Installation of Sprinkler Systems). The GENERAL CONTRACTOR shall provide no less than 24 spare heads of each type and/or temperature rating.
- B. Cabinet shall be constructed of 22-gauge steel with prime coat and manufacturer's baked enamel finish in color selected by the MEEPF CONSULTANT. Cabinet(s) shall be located in Fire Pump Room(s). Final location shall be as directed by the MEEPF CONSULTANT.

PART 3 – EXECUTION

3.1 GENERAL

- A. Install a complete combined fire standpipe and sprinkler system with all piping, valves, hangers, signs, valves, tests, etc., as indicated on Drawings and as specified herein.
- B. Furnish and install all drain piping, flushing, connections, drain plugs, drain valves, etc., at drain points and all low points.
- C. Seal all valves, not provided with tamper switches, in open position by approved means.
- D. Flushing connections shall conform, to NFPA 13 (Standard for the Installation of Sprinkler Systems). Include pressure gauges and 25mm inspector's test connections.
- E. Piping shall be run parallel to walls and beams. Before finalizing the location of any piping, consult with other trades so as to avoid interfering with their work.
- F. Care shall be exercised in the installation of the piping so that the system will drain by gravity, back through branches.
- G. All electrical devices associated with and/or listed within this Section including power and control wiring with the exception of main source of power from the building's electrical system shall be the sole responsibility of the GENERAL CONTRACTOR. This shall include but is not limited to conduit, wiring, termination of wiring, etc.

3.2 TRAINING**A. Provide instruction of the EMPLOYER'S personnel:**

1. Instruct the EMPLOYER'S personnel in proper starting sequences, operation, shutdown and maintenance procedures, including normal and emergency procedures.
2. Instruction shall be by personnel skilled in operation of equipment. Instructions for major equipment shall be provided by equipment manufacturers' representatives.
3. Instructions on automatic controls shall be by manufacturer's representative.

3.3 TESTS**A. General:**

1. The entire works shall be fully tested in stages as the work proceeds and on completion of work as applicable.
2. To provide during normal working hours, all necessary labours, instruments, equipment, materials, fuel, power and maker's representatives, to carry out such tests as may be necessary to satisfy the MEEPF CONSULTANT that the installation meets the requirement and intent of the specification as well as such tests required by NFPA 13 and Local Code Authority.
3. All tests shall be made in the presence of the MEEPF CONSULTANT or his representative or any inspecting authority.
4. Tests described hereinafter and including all tests prescribed by the Authority having jurisdiction shall be carried out. Any tests proved unsatisfactory shall be repeated to the satisfaction of the inspecting parties.
5. To provide skilled technicians/professional MEEPF CONSULTANTS to commission the plant and associated controls to the satisfaction of the MEEPF CONSULTANT. The skilled technicians / professional MEEPF CONSULTANTS will be required to demonstrate the correct procedures in starting and stopping the plant, running the various items of equipment under automatic and manual control and the correct maintenance of the plant.
6. Water flow rates of all equipment shall be adjusted to design conditions. Complete results of adjustments shall be recorded and submitted.

B. On-Site Testing and Commissioning:

1. Refer to Section 210800 "Commissioning" for commissioning requirements.
2. Two months prior to completion, submit a detailed programme for conducting on-site acceptance tests and commissioning for the MEEPF CONSULTANT's approval.
3. Start up, operate, test and adjust the systems in accordance with the agreed programme. The setting shall be supervised by the MEEPF CONSULTANT, who shall remain on site until he thinks that the equipment are operating satisfactorily and accepted. Advise and co-ordinate with the manufacturer's representatives so that all testing is carried out according to the agreed programme.
4. The whole installation shall be given the following tests to bring the plant into running order. The MEEPF CONSULTANT shall be given reasonable notice together with a copy of recorded test results, not less than seven (7) days, regarding the nature of tests, the

time and location. Acceptance tests will only be witnessed by the MEEPF CONSULTANT when the submitted tests results are found satisfactorily.

5. All instruments, tools, materials and labour required to perform these tests shall be provided.
6. Before the tests are carried out, remove connected equipment and components which are liable to damage under test, and shall provide and fix all the necessary gauges, blanking flanges, etc.
7. During system erection, the following tests shall be carried out:
 - a. Hose Reels
 - 1) The manufacturer's recognised test certificate for the hose reels shall be submitted to the MEEPF CONSULTANT for scrutiny and approval before their installation on site.
 - 2) The MEEPF CONSULTANT shall select at random hose reel for site testing conforming to the Local Code requirements.
 - b. Pipework Load Tests
 - 1) The MEEPF CONSULTANT shall select at his discretion any section of pipework for the following load tests as recommended in NFPA.
 - 2) Hangers shall be capable of withstanding the test loadings given in the NFPA Rules.
 - 3) When installed and subjected to the test loadings, the hanger shall not rupture, pull out, distort or otherwise be damaged and hangers shall not show permanent distortion resulting in a change in level or material position of the pipe to be supported in excess of 8 mm. If in-situ tests are conducted, appropriate safety precautions must be taken.
8. Prior to the system start-up, the following inspection, tests and pre-commissioning treatment shall be carried out:
 - a. Tanks and Level Switches
 - 1) The tanks shall be thoroughly cleaned with water and drained before city mains supply will feed in.
 - 2) Also before city mains supply will feed in, the level switch shall be simulated for the various cut-in and cut-out settings.
 - b. Pressure Switches
 - 1) The testing equipment arrangement for pressure switches and pressure gauges shall be as shown on the drawings or of an approved equivalent.
 - 2) The testing equipment shall be suitable for nominal working pressure of 2.5 MPa (PN 25) conforming to the BS, e.g. the pipework shall conform to BS 1387:1967 Table 3 for class C heavy galvanized mild steel tube.
 - 3) The pressure settings corresponding for pump cut-in (lamp and buzzer energised) and pump cut-out (lamp and buzzer de-energised) and reset differentials shall be tested by applying the hand jacking pump or by opening the test valve.

- 4) The pressure gauges to be tested shall be connected as shown on the drawing in lieu of the pressure switch. The gauges to be tested shall be regarded acceptable when the pressure readings of all three gauges are the same throughout the jacking pressure range varied by applying the hand pump.

c. Flow Switches

- 1) The testing equipment for the flow switches shall be as shown on the drawings or of an equivalent approved by the MEEPF CONSULTANT.
- 2) The calibration test equipment shall provide a flow of 1 l/s over the vane of the flow switch in the direction shown, to be confirmed by the direct reading flow meter.
- 3) The flow switch contacts shall make with energisation of the lamp and the buzzer, upon a flow not greater than 1 l/s flowing over the vane in the correct direction.

d. Hydrostatic Tests

- 1) All parts of the water circuit shall be filled with water before hydrostatic pressure testing, and pump running tests for verification of pressure and flow rate, are conducted.
- 2) The hand jacking pump shall be applied to increase the system pressure to 2 times the working pressure or 1.5 times the working pressure plus 350 kPa whichever is the lower but in any case not less than 700 kPa. The pressure shall be maintained for a period not less than 24 hours.
- 3) Where any section of pipework or equipments unable to withstand the maximum pipework test pressure, it shall be isolated during the pipework test then that section of pipework or equipment shall be re-tested at the appropriate test pressure.
- 4) The working pressure for various systems shall be as shown on the drawings.
- 5) Before performing the hydrostatic test, the following system component shall be fulfilled:

a) For Sprinkler System

- i. All gate valves shall be closed fully except the valves around the check meter position which shall be opened.
- ii. All the main stop valves and the subsidiary stop valves shall be opened or closed in order to provide isolated water tight sections for the hydrostatic pressure testing.
- iii. The pressure switches shall be isolated by the relevant valves or cocks.
- iv. The test and the drain valves shall be closed.
- v. The sprinkler inlet isolating valve shall be closed.

e. Cleaning and Flushing

- 1) Prior to start-up and satisfactorily hydraulic testing, clean the entire installation including all fittings and pipework and the like after installation and keep them in a new condition. All pumping systems shall be flushed and drained at least once through to get rid of contaminating materials. All pipes shall be rodded when

necessary to ensure clearance of debris, cleaning and flushing shall be carried out in sections as the installation becomes completed.

- 2) All strainers shall be inspected and cleaned out or replaced.
- 3) When the entire systems are reasonably clean. Warning signs shall be provided at cleaning and flushing. The cleaning and flushing shall:
 - a) Remove oil, grease and foreign residue from the pipework and fittings.
 - b) Pre-condition the metal surfaces to resist reaction with water or air.
 - c) Establish as initial protective film.
 - d) After cleaning and flushing, the system shall be drained and refilled with fresh water and left until the system is put into operation.
 - e) Details and procedures of the cleaning and flushing shall be submitted to the MEEPF CONSULTANT for approval.

f. Electrical Tests

- 1) Electrical tests shall comply with the current edition of IEE regulations and requirements enforced by local authorities.
- 2) Electrical insulation tests, earth electrode resistance test and cost amenity test shall apply to busbars, isolators and other equipment and wiring where applicable.
- 3) A 500V DC instrument shall be used to check the insulation resistance. The reading shall not be less than 1 mega-ohm in all instances.
- 4) Function simulation tests shall be performed to ensure that the systems have been installed to the control requirements as described in the specification therein.

g. Electrical Coupling

- 1) The direct coupling of the pump drivers shall be dismantled before the pump motor control panel is energised.
- 2) Demonstrate to the MEEPF CONSULTANT of acceptable clearances of the coupling alignment for ensuring satisfactory power transmission.
- 3) The coupling shall not be re-mated again till the correct motor rotation has been demonstrated with power drawn from the energised pump motor control panel.

h. Pump Churning Test

- 1) After the electrical pump motor control panel has been energised, pump churning tests shall be performed with the pump discharge valve closed.

i. A separate test shall be conducted for each pump. With each pump running for thirty minutes, the following results shall be obtained at a 3-minute intervals:

- 1) The temperature of the churning water and the tank water.
- 2) The flow rate of the churning water to be measured by collecting the flow into a metal tank via a plastic hose.

- 3) The temperature of the motor casing with the pump room door being closed.
- 4) The pump room temperature at a point close to the ceiling slab and at a point 600 mm above finished floor level adjacent to the room door.
- 5) The tank water temperature.

j. Pump Operating Test

Ensure to the satisfaction of the MEEPF CONSULTANT that the installation or portion thereof which has been set to work complies with all requirements including the following:

- 1) That the plant and apparatus shall be of robust construction and of capacity for the duty specified.
- 2) That all valves, switches, controls and the like are properly regulated and capable of proper operation and in the case of valves are capable of being shut-off.
- 3) That all apparatus shall be silent.
- 4) That all instruments are correctly calibrated and read accurately.
- 5) That all services are tested in accordance with the details of the relevant clauses of this Specification.
- 6) Pump control tests for the hydrant and wet and dry systems at the pump motor control panels shall be integrated with other relevant test requirements for those systems in this Specification.

9. The various systems shall be operated for the following system performance tests:

a. Sprinkler System

- 1) The system shall be tested to confirm that the pressure and flow rate and control scheme conform to NFPA requirements.
- 2) The start and stop of each jockey pump and each main pump shall be tested by opening/closing of the test and drain valve stemming from the installation valve.
- 3) The water flow rate and pressure for each installation shall be tested by using the proving of water test equipment (i.e. direct reading flow meter) according to NFPA. At the same time, the motor gong shall sound properly. During the test, the main duty pump shall be in full operation within 30 seconds, and for the standby pump if required, within 45 seconds.
- 4) The end-of-pipe test valve at the hydraulically remotest end of the system shall be opened for testing the flow switch.
- 5) Other end-of-pipe test valves shall be selected by the MEEPF CONSULTANT at his discretion for flow switch alarm testing with simultaneous purpose of testing the pressure switches.
- 6) Each set of pressure switches shall be tested by opening end-of-pipe test valves for starting of jockey pumps, sprinkler main pumps.

B. Statutory Authorities Tests and Inspections:

1. As and when notified in writing or instructed by the MEEPF CONSULTANT, the Contractor shall submit as-built drawing and attend all tests and inspections carried out by the Local Authorities, and shall forthwith execute free of charge any rectification work ordered by the MEEPF CONSULTANT as a result of such tests and inspections which determine non-compliance with Statutory Regulation. Some of these tests may take place after the issue of Taking Over Certificate and the GENERAL CONTRACTOR shall make all allowances in this respect.
2. Submit of all necessary forms and shop drawings/as-built drawings to the Statutory Authorities which shall conform in layout to the latest Architectural plans submitted kept by these Authorities.
3. The submission shall comply with the requirements set forth in the current Codes of Practice and circular letters of the Statutory Authorities. The shop drawings to be submitted shall be forwarded to the MEEPF CONSULTANT for checking before submission.
4. The GENERAL CONTRACTOR shall ensure that his submission shall not delay the subsequent inspection and test; otherwise he shall be fully responsible for any consequence due to his delay.

C. Preliminary Commissioning Checks:

1. Ensure that all equipment is thoroughly cleaned, lubricated and checked for serviceability before setting to work. Particular attention is drawn to the removal of building debris from the pipework systems.
2. Special attention is drawn to the need for thoroughly flushing out all pipework systems to ensure that all foreign matter is removed.
3. All automatic controls and safety devices shall be inspected and checked for service ability before the working fluid or electricity is applied to the system.

D. Commissioning:

1. When the various installations have been completed and the preliminary commissioning checks carried out, the GENERAL CONTRACTOR shall set to work, regulate and calibrate all system in the entire installation. Special attention shall be paid to the following items:
2. That all valves, switches, controls, etc. are regulated and capable of proper operation and in the case of isolation valves that they are capable of tight shut off.
3. That all apparatus is silent in accordance with the requirements of this Specification.
4. That all instruments are correctly calibrated and read accurately.
5. That all services are tested in accordance with the details in the relevant clauses of this Specification.
6. Operate pumps, pressure reducing sets, etc. to ensure that all control systems are functioning correctly and are properly set, sequenced or interlocked.

E. Final Acceptance Tests:

1. Following commissioning of the entire installation, and prior to issue of Taking Over Certificate. The GENERAL CONTRACTOR shall carry out final acceptance tests in accordance with a programme to be agreed with the MEEPF CONSULTANT.
2. Should the results of the acceptance tests show that plant, systems and/or equipment fail to perform to the efficiencies or other performance figures as given in this Specification, the GENERAL CONTRACTOR shall adjust, modify and if necessary replace the equipment without further payment in order that the required performance can be obtained.
3. Where acceptance tests are required by the relevant Authorities having jurisdiction, these tests shall be carried out by the GENERAL CONTRACTOR prior to the issue of Taking Over Certificate to the acceptance of the Authorities.

3.4 ALARMS

- A. All pump alarms, both local and remote, shall be tested. Supervisory alarms for diesel shall be electrically tested for low oil pressure, high engine jacket coolant temperature, shutdown from over speed, battery failure and battery charger failure.

3.5 CLEANING AND ADJUSTING

- A. Brush and clean all work prior to concealing, painting and acceptance. Perform in stages if directed.
- B. Painted or exposed work soiled or damaged: Clean and repair to match adjoining work before final acceptance.
- C. Remove debris from inside and outside of materials and equipment.
- D. Flush out piping after installation.
- E. Adjust valves and automatic control devices
- F. Disinfections
 1. Disinfect underground water mains after installation and test in accordance with:
 - a. AWWA Standard C-60.
- G The GENERAL CONTRACTOR shall provide written proof of testing to the MEEPF CONSULTANT.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train EMPLOYER'S maintenance personnel to adjust, operate, and maintain wet pipe sprinkler system. Refer to Section 210800 "Commissioning." Provide video recording of all training sessions.

END OF SECTION

PART 1 - GENERAL.....

1.1 WORK INCLUDED.....

1.2 SUBMITTAL DATA

1.3 REFERENCE STANDARDS

1.4 COORDINATION

PART 2 - PRODUCTS

2.1 PREACTION SPRINKLER SYSTEM (DOUBLE-INTERLOCKED)

PART 3 - EXECUTION

3.1 INSTALLATION

3.2 TEST UPON COMPLETION.....

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PART 1 - GENERAL**1.1 WORK INCLUDED**

- A. Provide all labour, materials, products, equipment and services to supply and install Double-Interlocked Pre-action Systems as indicated on the Drawings and specified in this Section of the Specifications.
- B. The work essentially shall include, but not necessarily be limited to the following items:
 - 1. Tapping of Pre-Action pipe at nearest sprinkler mains.
 - 2. Supply and installation of a complete Double-Interlocked Pre-action system including pipings and appurtenances.
 - 3. Flushing prior to charging of newly installed fire protection system.
 - 4. Provision of shop drawings suitable for submission to the local authority, as built drawings.
 - 5. Testing and Commissioning (includes hydrostatic testing of the entire piping system or floor involved).
 - 6. Liaison with local authority to obtain all necessary certificates and approvals including the completion of all forms and payment of any fees and charges. All costs for all tests required by local authority shall be included.

1.2 SUBMITTAL DATA

- A. Submittal drawings shall be reviewed and incorporate requirements of local authorities. Drawings shall be certified correct prior to submission to Consultant.
- B. Submit system layout drawings, component Shop Drawings, specifications for Consultant's review prior to commencing installation.
- C. Upon completion of the installation, recalculate systems and submit hydraulic design data based on as-built installation.
- D. Obtain all approvals before proceeding with work.

1.3 REFERENCE STANDARDS

- A. Refer to the General Provisions.
- B. All system components must be UL listed and FM Approved type.

1.4 COORDINATION

- A. Refer to final Architectural Reflected Ceiling Plans and co-ordinate locations of sprinkler heads with lighting and other ceiling mounted components. Co-ordinate sprinkler piping to avoid interference with all other services.

PART 2 - PRODUCTS**2.1 PREACTION SPRINKLER SYSTEM (DOUBLE-INTERLOCKED)**

- A. Provide a complete automatically controlled double-interlocked pre-action type sprinkler system. Preferably package type system, for Client evaluation. Otherwise, system shall comply item 2.1.B.
- B. System shall be complete with:
 - 1. Pre-Action Valve.
 - 2. Trim piping and components including:
 - a. Priming Valve (normally open)
 - b. Strainer
 - c. Spring Loaded Check Valve
 - d. Alarm Test Valve (normally closed)
 - e. Auxillary Drain Valve (normally closed)
 - f. Drip Check Valve
 - g. Alarm Shut-Off Valve (normally open)
 - h. Pressure Operated Relief Valve
 - i. Emergency Release
 - j. Priming Pressure Water Gauge and Valve
 - k. Water Supply Pressure Gauge and Valve
 - l. Drain Cup
 - m. Flow Test Valve (normally closed)
 - 3. Water flow alarm equipment:
 - a. Alarm Pressure Switch
 - b. Water Motor Alarm
 - c. Strainer
 - d. Electric Alarm Bell
 - 4. Supervisory Air Supply:
 - a. System Pressure Gauge and Valve
 - b. Soft Seat Swing Check Valve
 - c. Air Pressure Supervisory Switch
 - 5. Release System:
 - a. Solenoid Valve
 - b. Electric Release Module Trim
 - c. System Control Panel
 - d. Electric Detection System
 - e. Accelerator
 - f. Accelerator Isolation Valve
 - g. Pneumatic Actuator
 - 6. Air Supply:
 - a. Air Compressor
 - b. Control Switch
 - c. Dehydrator
- C. System operation shall conform to the following sequence:

1. When the detection system operates, system control panel energizes the solenoid valve to open.
 2. Alarms activate, but the pre-action valve will NOT open until a sprinkler opens relieving supervisory pressure from the sprinkler system.
 3. When a sprinkler opens, supervisory pressure in the sprinkler piping is reduced causing the pneumatic actuator to open.
 4. After both the electric detection system activates and supervisory pressure in the sprinkler system have been lost, pressure is released from the priming chamber to open drain cup.
 5. The pre-action valve clapper opens to allow water to flow into the system piping and alarm devices, causing water motor alarm and water flow alarms connected to alarm pressure switch to activate.
- D. Interfacing with the other trades. The fire protection contractor shall also provide all necessary wirings and connection from Preaction panel to the following:
1. Precision AC contact for the system shutdown. (if any)
 2. Fire alarm monitor module for alarm monitoring.
 3. Security contact for security door release. (if any)
- E. System pressure and type of units (materials and equipments) Contractor to provide calculation for Engineers approval prior in placing of order of equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

System installation in general shall be conducted by experienced technicians and supervised by engineer that has been successfully installed a fire extinguishing system of the same type and designed as specified herein. The services of the qualified manufacturer's representatives, experienced in the installation and operation of the system being provided shall be furnished to supervised the preliminary testing, including final testing, system adjustment and instructions.

3.2 TEST UPON COMPLETION

Upon completion of the installation, the system shall be subject for functional and operational test including tests in place of each field devices. When all required corrections have been rectified, the system shall be re-tested and the representative of the owner shall be notified of the readiness for final inspection. At this time, any and all required test shall be repeated and any defects corrected until the system is found to be acceptable.

END OF SECTION

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PART 1 - GENERAL**1.1 RELATED DOCUMENTS**

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

1.2 SUMMARY

- A. Section includes portable, hand-carried and wheeled Type fire extinguishers including mounting brackets for fire extinguishers.
- B. EMPLOYER-Furnished Material: Hand-carried and Wheeled Type fire extinguishers.
- C. Related Sections:
 - 1. Division 10 Section "Fire Extinguisher Cabinets."
 - 2. Division 21 Section "Fire-Suppression Piping" for hose systems, racks, and valves.
 - 3. Division 21 Section "Commercial Kitchen Hoods" for fire extinguishing systems provided as part of commercial kitchen exhaust hoods.

1.3 UNIT PRICES

- A. Work of this Section is affected by USD and Peso.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rating and classification, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguisher and mounting brackets.
- B. Product Schedule: For fire extinguishers. Coordinate final fire extinguisher schedule with fire protection cabinet schedule to ensure proper fit and function.
- C. Operation and Maintenance Data: For fire extinguishers to include in maintenance manuals.
- D. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

- A. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."
- B. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
 - 1. Provide fire extinguishers approved, listed, and labeled by FMG.
- C. Pre-installation Conference:
 - 1. Review methods and procedures related to fire extinguishers including, but not limited to, the following:
 - a. Schedules and coordination requirements.

1.6 COORDINATION

- A. Coordinate type and capacity of fire extinguishers with fire protection cabinets to ensure fit and function.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10.
 - b. Faulty operation of valves or release levers.
 - 2. Warranty Period: One (1) year from date of Substantial Completion.

PART 2 - PRODUCTS**2.1 PORTABLE, HAND-CARRIED FIRE EXTINGUISHERS**

- A. Fire Extinguishers: Type, size, and capacity for each fire protection cabinet mounting bracket indicated.
 - 1. Valves: Manufacturer's standard.
 - 2. Handles and Levers: Manufacturer's standard.
 - 3. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B inspections, maintenance, and recharging.
- B. Multipurpose Dry-Chemical Type: UL-rated, with monoammonium phosphate-based dry chemical in manufacturer's standard enameled container with nominal capacity as follows:
- C. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:60-B:C, 10-lb (4.5-kg) 20-A:120-B:C, 20-lb (9.1-kg) nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.
- D. Carbon Dioxide Type: UL-rated 10-B:C, 10-lb (4.5-kg) 10-B:C, 20-lb (9.1-kg) nominal capacity, with carbon dioxide in manufacturer's standard enameled-metal container.

2.2 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard galvanized steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or red baked-enamel finish.
- B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by ARCHITECT.
 - 1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied to mounting surface.
 - a. Orientation: Horizontal.

2.3 WHEELED FIRE EXTINGUISHERS

- A. Wheeled Fire Extinguishers: Type, size, and capacity for locations indicated, complete with carriage.
 - 1. Carriage: Fabricated from enameled-steel pipe, complete with hanger assembly, long-range nozzle, hose, and semipneumatic solid-rubber tires.
 - a. Hose: 15 feet (4.6 m).
- B. Multipurpose Dry-Chemical Type: UL-rated 30-A:160-B:C, 50-lb (23-kg) nominal capacity, with monoammonium phosphate-based dry chemical in stored pressure, enameled-steel aluminum steel or -aluminum container.
- C. Carbon Dioxide Type: UL-rated 20-B:C, 50-lb (23-kg), with carbon dioxide in manufacturer's standard enameled-metal container.

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged fire extinguishers.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install fire extinguishers and mounting brackets in locations indicated and in compliance with requirements of authorities having jurisdiction.
 - 1. Mounting Brackets: 54 inches (1372 mm) above finished floor to top of fire extinguisher.
- B. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.

END OF SECTION

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

1.2 QUALITY ASSURANCE

1.3 CODES AND STANDARDS

1.4 SUBMITTALS

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

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PART 3 – EXECUTION

3.1 INSTALLATION

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PART 1 – GENERAL**1.1 DESCRIPTION OF WORK**

This Section and related Drawings describe the requirements for Total Flooding Clean Agent Fire Extinguishing Systems, controls and all related piping accessories.

1.2 QUALITY ASSURANCE

- A. Contractor firms shall be regularly engaged in the installation of gas extinguishing particularly systems using nitrogen agent whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. NFPA Compliance - All materials and installations shall comply with NFPA 2001 "Standard for Clean Agent Fire Extinguishing Systems".

1.3 CODES AND STANDARDS

The complete installation shall be carried out in accordance with the current issue of the applicable National, City, Municipal and Local Codes and Standards:

- A. American Society for testing and Materials (ASTM) :
 - A 53 - Pipe Steel Black and Hot-Dipped Zinc - Coated, Welded.
 - A 106 - Seamless Carbon Steel Pipe for High Temperature Service.
- B. Fire Code of the Philippines
- C. National Building Code
- D. National Electrical Code
- E. National Fire Protection Association (NFPA):
 - NFPA Standard 2001, Clean Agent Fire Extinguishing System
 - NFPA Standard 72, National Fire Alarm Code
- E. Philippine Electrical Code

1.4 SUBMITTALS

- A. Submit manufacturer's clean agent system equipment specifications, installation and start-up instructions, and capacity and ratings.
- B. Submit shop drawings indicating dimensions, weights, required clearances and methods of assembly of all components.
- C. Submit schematic wiring diagrams for all components, clearly indicating all required field electrical connections.
- D. Submit all information necessary for the complete supply and installation of the clean agent Extinguishing System.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. All materials used for the installation must be new, free from all defects and imperfections unless otherwise indicated. Handle all materials and components carefully to prevent damage, breaking, denting and scouring.
- B. Store the components in clean dry place. Protect from weather, dirt, fumes, water, construction debris, and physical damage.

PART 2 – PRODUCTS**2.1 CLEAN AGENT FIRE EXTINGUISHING SYSTEM**

- A. The extinguishing system for this project shall use NOVEC 1230 as the extinguishing agent.
- B. Clean agent extinguishing system shall be provided to all areas as specified and as indicated in the drawings including above ceiling spaces. The system shall be configured into a multizone scheme where in the clean agent gas supply shall be calculated / determined based on the biggest single hazard.
- C. The system shall be automatically and manually controlled that should be suitable for total flooding application. Zone status shall be indicated in the centralized fire extinguishing control panel.
- D. The system supplier shall provide, install and guarantee the performance and selection of system components that conforms to the design intent as well as NFPA 2001 latest edition and meet the approval of the authority having jurisdiction.
- E. The clean agent fire extinguishing system shall consist of but not limited to the following:
 - 1. Mechanical Components and Control Accessories
 - a. Clean- Agent Cylinder Units

The cylinder unit shall be the supply source of extinguishing agent and it shall consist of the storage cylinders, pilot cylinders, pressure gauges assembly, loop pipes, manifold pipes and stanchion or the cylinder brackets / supports.
 - b. Selector Valve

Selector valve shall be provided per zone hazard. They shall be installed in a common manifold pipe so that those shall open automatically to release NOVEC1230 gas for fire extinguishing by the application of gas pressure from the pilot cylinder. The selector valve shall be used for selectively directing the clean agent gas flow to the affected hazard.
 - c. Safety Vent

Safety vent of rupture disc type or equivalent shall be provided between the manifold pipes and the selector valve. This safety device is intended to protect the piping and the equipment when pressure rises abnormally during discharge.

d. Relief Valve

Relief valve shall be provided as part of the control tubing that will prevent unintentional system operation due to the accumulation of pressure and / or due to a leak from the actuating cylinder.

e. Discharge Nozzle

Discharge nozzles shall be provided to control the discharge rate and uniformly distributes the extinguishing agent into the hazard space. All nozzles for room hazards shall be ceiling mounting type with 360° radial distribution patterns. The above ceiling space and under raised floor shall be sidewall mounting, horn type with 180° distribution patterns.

2. Electrical Components and Control Accessories

a. Smoke Detector

Addressable / Analog type photoelectric smoke detector configured in a crossed zone scheme operation shall be provided on each room and other protected hazards. These devices are intended to control the discharge of the extinguishing agent automatically.

b. Gas Discharge Station

Addressable manual control box that contains the discharge switch, shall be provided near the entrance on each room and other protected hazards. These devices are intended to be used by the human occupants to control the discharge of the extinguishing agent manually.

c. Gas Abort Control Station

Addressable abort control station shall be installed adjacent to the manual discharge station to prevent the discharge of clean agent gas during the preset time delay period.

d. Alarm Bell

Fire alarm bell shall be provided that shall operate to give warning to occupants in cases that automatic fire detectors sense the presence of fire.

e. Horn/ Strobe

Audible horn & strobe light shall be provided to give information to the personnel/occupants when the extinguishing agent is about to discharge (by horn) and when it has been fully discharged (by strobe).

f. Fire Extinguishing Control Panel

The centralized addressable type fire detection & alarm control panel to control and monitor the operation of each protected hazard shall be used. The panel shall have a control unit that will constitute the basic control switches and system monitoring LCD display panel.

g. Work Station Graphic Display Unit

A computer set workstation fixed in a standard computer table shall consist of the following:

1. Monitor (21 inches) that will automatically pop up the graphic display map to indicate the location of the specific device in alarm or in trouble condition.
2. Key board/mouse control to perform the basic system control functions.
3. Line printer that automatically prints out in standard text form during alarm or trouble events.

h. Pressure Relief Damper

Pressure relief device with sufficient area opening to balance the air pressure at normal atmosphere during and after the agent full discharge shall be provided on each protected hazard. The system control interlock shall be configured so that this relief device shall automatically open before the start of the gas discharge and shall close automatically after the agent has been fully discharged.

i. Selector Switch

Selector switch shall be provided to all system where main reserve cylinder is available in the design.

3. Clean Agent Gas Piping System Components and Accessories

- a. Ferrous piping to be used shall be black or galvanized steel pipe, seamless Sched. 80 that conforms to either ASTM A 53 or ASTM A 106.
- b. Malleable or ductile iron fittings class 300 lbs. shall be used except fittings for the selector valve pipe manifold that should be class 600 lbs.
- c. Pipe brackets and supports shall be in accordance with the system manufacturer's instructions.

4. Control Wiring System and Accessories

- a. Wiring raceways or conduits to be used shall be Intermediate Metallic Conduit (IMC) with trade sizes in accordance with the requirement of Philippine Electrical Code (PEC) or National Electrical Code (NEC).
- b. All wires and cables shall be copper, soft drawn and annealed of 98% conductivity. These should be with minimum size of gage # 1.25mm square as per requirement of the equipment manufacturing.

F. System Sequence of Operation

1. Manual Operation

- a. If fire occurs
- b. Pull down the manual discharge station
 - Air conditioning system will stop
 - Related pressure relief damper open
- c. Cylinder valve solenoid immediately actuates
- d. ~~Pilot cylinder open~~

- e. Clean agent cylinders open
 - f. Related selector valve open
 - g. Clean agent gas discharge
 - Discharge indicator strobe/horn operates
 - h. Fire extinguish
2. Automatic Operation
- a. If fire occurs
 - b. Zone 1 smoke detector detects smoke
 - Fire alarm bell will activate
 - c. Zone 2 smoke detector detects smoke
 - d. Control “AND” gate switch on
 - Air conditioning system will stop
 - Related pressure relief damper open
 - e. Upon completion of the pre-set time delay
 - f. Cylinder valve solenoid actuates
 - g. Pilot cylinder open
 - h. Related selector valve open
 - i. Clean agent gas discharge
 - Discharge indicator strobe/horn operates.
 - j. Fire extinguish

PART 3 – EXECUTION

3.1 INSTALLATION

System installation in general shall be conducted by experienced technicians and supervised by engineer that has successfully installed a fire extinguishing system of the same type and designed as specified herein. The services of the qualified manufacturer's representatives, experienced in the installation and operation of the system being provided shall be furnished to supervise the preliminary testing, including final testing, system adjustment and instructions.

3.2 TEST UPON COMPLETION

Upon completion of the installation, the system shall be subject for functional and operational test (No Gas Discharge) including tests in place of each field devices. When all the required corrections have been rectified, the system shall be re-tested and the representative of the owner shall be notified of the readiness for final inspection. At this time, any and all required test shall be repeated and any defects corrected until the system is found to be acceptable.

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PART 1 - GENERAL**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Division 21 will be responsible to carry out the commissioning requirements specified in this Sections and other sections referenced. These include, but are not limited to, commissioning, enhanced commissioning, preparation of a detailed O&M manual, and detailed training of the EMPLOYER'S personnel.

1.2 SUMMARY

- A. Section Includes:
 - 1. Split Type Fire Pumps.
 - 2. Fire-pump accessories and specialties.
 - 3. Flowmeter systems.

1.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Fire pumps shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified [and the unit will be fully operational after the seismic event."
- B. Pump Equipment, Accessory, and Specialty Pressure Rating: 175 psig (1200 kPa) minimum unless higher pressure rating is indicated below.

1. Pump Discharge, risers	Refer to Equipment Schedule
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1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For fire pumps, motor drivers, and fire-pump accessories and specialties. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Seismic Qualification Certificates: For fire pumps, accessories, and components, from manufacturer.
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

- 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Retain first paragraph below for product certificates from manufacturers.
- E. Product Certificates: For each fire pump, from manufacturer.
- F. Source quality-control reports.
- G. Field quality-control reports.
- H. Operation and Maintenance Data: For fire pumps to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. NFPA Compliance: Comply with NFPA 20, "Installation of Stationary Pumps for Fire Protection."

1.6 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS**2.1 GENERAL REQUIREMENTS FOR CENTRIFUGAL FIRE PUMPS**

- A. Description: Factory-assembled and -tested fire-pump and driver unit.
- B. Base: Fabricated and attached to fire-pump and driver unit with reinforcement to resist movement of pump during seismic events when base is anchored to building substrate.
- C. Finish: Red paint applied to factory-assembled and -tested unit before shipping.

2.2 HORIZONTALLY MOUNTED, SINGLE STAGE SPLIT-CASE FIRE PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Provide packaged type fire pumps and jockey pump system, all assembled on a common base-plate. All components shall be ULC listed where applicable, and in accordance with the following specifications.
 - 2. Refer to Schedule for duty. Provide horizontal multi stage, split-case centrifugal pump, hydrostatically tested to twice the maximum working pressure or 2,413 kPa maximum. Provide ductile iron casing and cover with cast iron motor bracket, bronze impeller and wearing ring, and bronze shaft sleeve. Connected to a 3,600 rpm (max), solid shaft, open dripproof type motor.

3. Provide pumping unit complete with the following accessories:
 - a. One (1) concentric increaser, attached to the fire pump discharge complete with 20 mm automatic air release valve and 20 mm circulation relief valve set approximately 10% above operative discharge pressure.
 - b. One (1) UL listed and labelled fire pump control panel, and with a circuit breaker interrupting capacity amperes RMS symmetrical of two (2) complete with pressure switch suitable for 350 psi range.
 - B. Pump:
 1. Standard: UL 448, for split-case pumps for fire service.
 2. Number of Stages: Two.
 3. Casing: Axially split case, cast iron with ASME B16.1 pipe-flange connections.
 4. Impeller: Cast bronze, statically and dynamically balanced, and keyed to shaft.
 5. Wear Rings: Replaceable bronze.
 6. Shaft and Sleeve: Steel shaft with bronze sleeve.
 - a. Shaft Bearings: Grease-lubricated ball bearings in cast-iron housing.
 - b. Seals: Stuffing box with minimum of four rings of graphite-impregnated braided yarn and bronze packing gland.
 7. Mounting: Pump and driver shafts are horizontal, with pump and driver on same base.
 - C. Coupling: Flexible and capable of absorbing torsional vibration and shaft misalignment. Include metal coupling guard.
 - D. Driver:
 1. Standard: UL 1004A.
 2. Type: Electric motor; NEMA MG 1, polyphase Design B.
 - E. Capacities and Characteristics: (Refer to Equipment Schedule)
- 2.3 FIRE-PUMP ACCESSORIES AND SPECIALTIES**
- A. Pipe sizes for pump test header, relief valves, discharge cones, and number and size of manifold hose valves are set by NFPA 20, so are not required in this article.
 - B. Automatic Air-Release Valves: Comply with NFPA 20 for installation in fire-pump casing.
 - C. Circulation Relief Valves: UL 1478, brass, spring loaded; for installation in pump discharge piping.
 - D. Relief Valves:
 1. Description: UL 1478, bronze or cast iron, spring loaded; for installation in fire-suppression water-supply piping.
 - E. Inlet Fitting: Eccentric tapered reducer at pump suction inlet.
 - F. Outlet Fitting: Concentric tapered reducer at pump discharge outlet.
 - G. Discharge Cone: Closed type.
 - H. Hose Valve Manifold Assembly:

1. Standard: Comply with requirements in NFPA 20.
2. Header Pipe: ASTM A 53/A 53M, Schedule 40, galvanized steel with ends threaded according to ASME B1.20.1.
3. Header Pipe Fittings: ASME B16.4, galvanized cast-iron threaded fittings.
4. Automatic Drain Valve: UL 1726.
5. Manifold:
 - a. Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets.
 - b. Body: Flush type, brass or ductile iron, with number of outlets required by NFPA 20.
 - c. Nipples: ASTM A 53/A 53M, Schedule 40, galvanized-steel pipe with ends threaded according to ASME B1.20.1.
 - d. Adapters and Caps with Chain: Brass or bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
 - e. Escutcheon Plate: Brass or bronze; rectangular.
 - f. Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads.
 - g. Exposed Parts Finish: chrome plated.
 - h. Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."
6. Manifold:
 - a. Test Connections: Comply with UL 405 except provide outlets without clappers instead of inlets.
 - b. Body: Exposed type, brass, with number of outlets required by NFPA 20.
 - c. Escutcheon Plate: Brass or bronze; round.
 - d. Hose Valves: UL 668, bronze, with outlet threaded according to NFPA 1963 and matching local fire-department threads. Include caps and chains.
 - e. Exposed Parts Finish: chrome plated.
 - f. Escutcheon Plate Marking: Equivalent to "FIRE PUMP TEST."

2.4 FLOWMETER SYSTEMS

- A. Description: UL-listed or FM-Approved, fire-pump flowmeter system with capability to indicate flow to not less than 175 percent of fire-pump rated capacity.
- B. Pressure Rating: 350 psig (2413 kPa).
- C. Sensor: Annubar probe, orifice plate, or venturi unless otherwise indicated. Sensor size shall match pipe, tubing, flowmeter, and fittings.
- D. Permanently Mounted Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches (115 mm) in diameter. Include bracket or device for wall mounting.
 1. Tubing Package: NPS 1/8 or NPS 1/4 (DN 6 or DN 10) soft copper tubing with copper or brass fittings and valves.
- E. Portable Flowmeter: Compatible with flow sensor; with dial not less than 4-1/2 inches (115 mm) in diameter and with two 12-foot- (3.7-m-) long hoses in carrying case.

2.5 GROUT

- A. Standard: ASTM C 1107, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink and recommended for interior and exterior applications.
- C. Design Mix: 5000-psi (34-MPa), 28-day compressive strength.

- D. Packaging: Premixed and factory packaged.

2.6 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect fire pumps according to UL 448 requirements for "Operation Test" and "Manufacturing and Production Tests."
 - 1. Verification of Performance: Rate fire pumps according to UL 448.
- B. See Division 1 Section "Quality Requirements" for retesting and reinspecting requirements and Division 1 Section "Execution Requirements" for requirements for correcting the Work.
- C. Fire pumps will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine equipment bases and anchorage provisions, with Installer present, for compliance with requirements and for conditions affecting performance of fire pumps.
- B. Examine roughing-in for fire-suppression piping systems to verify actual locations of piping connections before fire-pump installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Fire-Pump Installation Standard: Comply with NFPA 20 for installation of fire pumps, relief valves, and related components.
- B. Equipment Mounting: Install fire pumps on concrete bases. Comply with requirements for concrete bases specified in Division 3 Section "Cast-in-Place Concrete."
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Install fire-pump suction and discharge piping equal to or larger than sizes required by NFPA 20.
- D. Support piping and pumps separately so weight of piping does not rest on pumps.
- E. Install valves that are same size as connecting piping. Comply with requirements for fire-protection valves specified in Division 21 Section "Fire-Suppression Standpipes." Division 21 Section "Wet-Pipe Fire-Suppression Sprinklers."

- F. Install pressure gages on fire-pump suction and discharge flange pressure-gage tapings. Comply with requirements for pressure gages specified in Division 21 Section "Fire-Suppression Standpipes." Division 21 Section "Wet-Pipe Fire-Suppression Sprinklers."
- G. Install piping hangers and supports, anchors, valves, gages, and equipment supports according to NFPA 20.
- H. Install flowmeters and sensors. Install flowmeter-system components and make connections according to NFPA 20 and manufacturer's written instructions.
- I. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.
- J. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

3.3 ALIGNMENT

- A. Align end-suction and split-case pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.
- B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.
- C. Align piping connections.
- D. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.

3.4 CONNECTIONS

- A. Comply with requirements for piping and valves specified in Division 21 Section "Fire-Suppression Standpipes." Division 21 Section "Wet-Pipe Fire-Suppression Sprinklers." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to pumps and equipment to allow service and maintenance.
- C. Connect relief-valve discharge to drainage piping or point of discharge.
- D. Connect flowmeter-system meters, sensors, and valves to tubing.
- E. Connect fire pumps to their controllers.

3.5 IDENTIFICATION

- A. Identify system components. Comply with requirements for fire-pump marking according to NFPA 20.

3.6 FIELD QUALITY CONTROL

- A. Test each fire pump with its controller as a unit. Comply with requirements for electric-motor-driver fire-pump controllers specified in Division 21 Section "Controllers for Fire-Pump Drivers."

- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Tests and Inspections:
 - 1. After installing components, assemblies, and equipment including controller, test for compliance with requirements.
 - 2. Test according to NFPA 20 for acceptance and performance testing.
 - 3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 4. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 5. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Components, assemblies, and equipment will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.
- G. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Hoses are for tests only and do not convey to EMPLOYER.

3.7 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.

3.8 DEMONSTRATION

- A. Engage a factory-authorized service representative to train EMPLOYER's maintenance personnel to adjust, operate, and maintain fire pumps.

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PART 1 - GENERAL**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Division 21 will be responsible to carry out the commissioning requirements specified in this sections and other sections referenced. These include, but are not limited to, commissioning, enhanced commissioning, preparation of a detailed O&M manual, and detailed training of the EMPLOYER'S personnel.

1.2 SUMMARY

- A. Section Includes:
 - 1. Multistage, vertical in-line pressure-maintenance pumps.

1.3 PERFORMANCE REQUIREMENTS

- A. Pump Equipment, Accessory, and Specialty Pressure Rating: psig (1200 kPa) minimum unless higher pressure rating is indicated.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, performance curves, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For pumps, accessories, and specialties. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Field quality-control reports.
- D. Operation and Maintenance Data: For pumps to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.6 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS**2.1 MULTISTAGE, PRESSURE-MAINTENANCE PUMPS**

- A. Description: Factory-assembled and -tested, multistage, barrel-type vertical pump as defined in HI 2.1-2.2 and HI 2.3; designed for surface installation with pump and motor direct coupled and mounted vertically.
- B. Pump Construction:
 - 1. Barrel: Stainless steel.
 - 2. Suction and Discharge Chamber: Cast iron with flanged inlet and outlet.
 - 3. Pump Head/Motor Mount: Cast iron.
 - 4. Impellers: Stainless steel, balanced, and keyed to shaft.
 - 5. Pump Shaft: Stainless steel.
 - 6. Seal: Mechanical type with carbon rotating face and silicon-carbide stationary seat.
 - 7. Intermediate Chamber Bearings: Aluminum-oxide ceramic or bronze.
 - 8. Chamber-Base Bearing: Tungsten carbide.
 - 9. O-Rings: EPDM or NBR.
- C. Motor: Single speed with permanently lubricated ball bearings and rigidly mounted to pump head. Comply with requirements in Division 21 Section "Common Motor Requirements for Fire Suppression Equipment."
 - 1. Power Cord: Factory-connected to motor for field connection to controller and at least 10 feet (3 m) long.
- D. Nameplate: Permanently attached to pump and indicating capacity and characteristics.
- E. Capacities and Characteristics: Refer to Equipment Schedule

PART 3 - EXECUTION**3.1 EQUIPMENT INSTALLATION**

- A. NFPA Standard: Comply with NFPA 20 for installation of pressure-maintenance pumps.
- B. Base-Mounted Pump Mounting: Install pumps on concrete bases. Comply with requirements for concrete bases specified in Division 3 Section "Cast-in-Place Concrete".
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 5. Attach pumps to equipment base using anchor bolts.
- C. Install multistage pressure-maintenance pumps according to HI 1.4.
- D. Install vertical-turbine pressure-maintenance pumps according to HI 2.4.

3.2 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Pressure-maintenance pumps will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.3 ADJUSTING

- A. Lubricate pumps as recommended by manufacturer.
- B. Set field-adjustable pressure-switch ranges as indicated.

3.4 COMMISSIONING

- A. Refer to Section 210800 "Commissioning" for commissioning requirements.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train EMPLOYER'S maintenance personnel to adjust, operate, and maintain jockey pumps.

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PART 1 - GENERAL**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Division 21 will be responsible to carry out the commissioning requirements specified in this Sections and other sections referenced. These include, but are not limited to, commissioning, enhanced commissioning, preparation of a detailed O&M manual, and detailed training of the EMPLOYER'S personnel.

1.2 SUMMARY

- A. Section Includes:
 - 1. Full-service, reduced-voltage closed transition controllers rated 600 V and less.
 - 2. Limited-service controllers rated 600 V and less.
 - 3. Remote alarm panels.
 - 4. Low-suction-shutdown panels.
 - 5. Interlocking/Alternating
- B. Related Sections:
 - 1. Division 21 Section "Pressure-Maintenance Pumps" for pressure-maintenance-pump (jockey-pump) controllers.

1.3 DEFINITIONS

- A. ATS: Automatic transfer switch(es).
- B. ECM: Electronic control module.
- C. MCCB: Molded-case circuit breaker.
- D. N.O.: Normally open.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Fire-pump controllers and alarm panels shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For each type of product indicated. Include dimensioned plans, elevations, sections, details, and attachments to other work, including required clearances and service spaces around controller enclosures.
 - 1. Show tabulations of the following:

- a. Each installed unit's type and details.
 - b. Enclosure types and details for types other than NEMA 250, Type 2.
 - c. Factory-installed devices.
 - d. Nameplate legends.
 - e. Short-circuit current (withstand) rating of integrated unit.
 - f. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices.
 - g. Specified modifications.
 2. Detail equipment assemblies and indicate dimensions, weights, loads, method of field assembly, components, and location and size of each field connection.
 3. Schematic and Connection Diagrams: For power, signal, alarm, and control wiring and for pressure-sensing tubing.
- C. Qualification Data: For qualified testing agency.
- D. Seismic Qualification Certificates: For each type of product indicated, from manufacturer.
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Product Certificates: For each type of product indicated, from manufacturer.
- F. Manufacturer's factory test reports of fully assembled and tested equipment.
- G. Source quality-control reports.
- H. Field quality-control reports.
- I. Operation and Maintenance Data: For each type of product indicated to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for setting field-adjustable timers, controls, and status and alarm points.
 2. Manufacturer's written instructions for testing, adjusting, and reprogramming microprocessor-based logic controls.

1.6 QUALITY ASSURANCE

- A. Testing Agency Qualifications: Member company of an NRTL.
- B. Source Limitations: Obtain fire-pump controllers and all associated equipment from single source or producer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with standards of authorities having jurisdiction pertaining to materials and installation.
- E. Comply with NFPA 20 and NFPA 70.

- F. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

1.7 DELIVERY, STORAGE AND HANDLING

- A. Store controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subject to weather, protect controllers from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; connect factory-installed space heaters to temporary electrical service.

1.8 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Ambient Temperature Rating: Not less than 40 deg F (5 deg C) and not exceeding 122 deg F (50 deg C) unless otherwise indicated.
 - 2. Altitude Rating: Not exceeding 6600 feet (2011 m) unless otherwise indicated.
- B. Interruption of Existing Electric Service: Notify EMPLOYER no fewer than seven days in advance of proposed interruption of electric service, and comply with NFPA 70E.

1.9 COORDINATION

- A. Coordinate layout and installation of controllers with other construction including conduit, piping, fire-pump equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels. Ensure that controllers are within sight of fire-pump drivers.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.10 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Indicating Lights: Two of each type and color of lens installed; two of each type and size of lamp installed.
 - 2. Auxiliary Contacts: One for each size and type of magnetic contactor installed.
 - 3. Power Contacts: Three for each size and type of magnetic contactor installed.
 - 4. Contactor Coils: One for each size and type of magnetic controller installed.
 - 5. Relay Boards: One for each size and type of relay board installed.
 - 6. Operator Interface: One microprocessor board(s), complete with display and membrane keypad.

PART 2 - PRODUCTS**2.1 FULL-SERVICE CONTROLLER****A. Method of Starting:**

1. Pressure-switch actuated.
 - a. Water-pressure-actuated switch and pressure transducer with independent high- and low-calibrated adjustments responsive to water pressure in fire-suppression piping.
 - b. System pressure recorder, electric ac driven, with spring backup.
 - c. Programmable minimum-run-time relay to prevent short cycling.
 - d. Programmable timer for weekly tests.
2. Magnetic Controller: Wye-delta (closed transition) type.
3. Solid-State Controller: Reduced-voltage type.
4. Emergency Start: Mechanically operated start handle that closes and retains the motor RUN contactor independent of all electric or pressure actuators.

B. Method of Stopping: non-automatic shutdown.**C. Capacity: Rated for fire-pump-driver horsepower and short-circuit-current (withstand) rating equal to or greater than short-circuit current available at controller location.****D. Method of Isolation and Overcurrent Protection: Interlocked isolating switch and nonthermal MCCB; with a common, externally mounted operating handle, and providing locked-rotor protection.****E. Door-Mounted Operator Interface and Controls:**

1. Monitor, display, and control the devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
2. Method of Control and Indication:
 - a. Microprocessor-based logic controller, with multiline digital readout.
 - b. Membrane keypad.
 - c. LED alarm and status indicating lights.
3. Local and Remote Alarm and Status Indications:
 - a. Controller power on.
 - b. Motor running condition.
 - c. Loss-of-line power.
 - d. Line-power phase reversal.
 - e. Line-power single-phase condition.
4. Audible alarm, with silence push button.
5. Nonautomatic START and STOP push buttons or switches.

F. Optional Features:

1. Extra Output Contacts:
 - a. One N.O. contact(s) for motor running condition.
 - b. One set(s) of contacts for loss-of-line power.
 - c. One each, Form C contacts for high and low reservoir level.
2. Local alarm bell.

3. Door-mounted thermal or impact printer for alarm and status logs.
4. Operator Interface Communications Ports: USB, Ethernet, and RS485.

G. ATS:

1. Complies with NFPA 20, UL 218 and UL 1008.
2. Integral with controller as a listed combination fire-pump controller and power transfer switch.
3. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.
4. Allows manual transfer from one source to the other.
5. Alternate-Source Isolating and Disconnecting Means: Integral molded-case switch, with an externally mounted operating handle.
6. Alternate-Source Isolating and Disconnecting Means: Mechanically interlocked isolation switch and circuit breaker rated at a minimum of 115 percent of rated motor full-load current, with an externally mounted operating handle; circuit breaker shall be provided with nonthermal sensing, instantaneous-only short-circuit overcurrent protection to comply with available fault currents.
7. Local and Remote Alarm and Status Indications:
 - a. Normal source available.
 - b. Alternate source available.
 - c. In normal position.
 - d. In alternate position.
 - e. Isolating means open.
8. Audible alarm, with silence push button.
9. Nonautomatic (manual, nonelectric) means of transfer.
10. Engine test push button.
11. Start generator output contacts.
12. Timer for weekly generator tests.
13. Generator tests.

2.2 ATS

A. General Requirements for Standalone ATS:

1. Complies with NFPA 20, UL 218 and UL 1008.
 2. Listed by an NRTL for fire-pump service.
 3. Automatic and nonautomatic operation.
 4. Separate from controller and individually listed as a fire-pump-controller power transfer switch.
 5. Automatically transfers fire-pump controller from normal power supply to alternate power supply in event of power failure.
 6. Allows manual transfer from one source to the other; factory assembled, wired, and tested.
- B. Capacity: Rated for fire-pump-driver horsepower and short-circuit-current (withstand) rating equal to or greater than short-circuit current available at ATS location.
- C. Alternate-Source Isolating and Disconnecting Means: Integral molded-case switch, with an externally mounted operating handle.
- D. Alternate-Source Isolating and Disconnecting Means:
1. Mechanically interlocked isolation switch and circuit breaker rated at a minimum of 115 percent of rated motor full-load current.
 2. Externally mounted operating handle.
 3. Circuit breaker provided with nonthermal sensing, instantaneous-only, short-circuit overcurrent protection.

4. Equipped with a voltage surge arrester.
- E. Door-Mounted Operator Interface and Controls:
 1. Monitor, display, and control devices, alarms, functions, and operations listed in NFPA 20 as required for drivers and controller types used.
 2. Method of Control and Indication:
 - a. Microprocessor-based logic controller, with multiline LCD readout. Membrane keypad.
 - b. LED alarm and status indicating lights.
 3. Local and Remote Alarm and Status Indications:
 - a. Normal source available.
 - b. Alternate source available.
 - c. In normal position.
 - d. In alternate position.
 - e. Isolating means open.
 4. Audible alarm, with silence push button.
 5. Nonautomatic (manual, nonelectric) means of transfer.
 6. Engine test push button.
 7. Start generator output contacts.
 8. Timer for weekly generator tests
- F. Optional Features:
 1. Extra Output Contacts:
 - a. One each, Form A; isolating means open.
 - b. One each, Form C; in normal or alternate position
 2. Door-mounted thermal or impact printer for alarm and status logs.
 3. Operator Interface Communications Ports: USB, Ethernet, and RS485.

2.3 REMOTE ALARM PANELS

- A. General Requirements for Remote Alarm Panels: Comply with NFPA 20 and UL 218 listed by an NRTL for fire-pump service.
- B. General Requirements for Remote Alarm Panels: Factory assembled, wired, and tested.
- C. Supervisory and Normal Control Voltage: source.
- D. Audible and Visual Alarm and Status Indications:
 1. Driver running.
 2. Loss of phase.
 3. Phase reversal.
 4. Supervised power on.
 5. Common trouble on the controller.
 6. If retaining second option in subparagraph above, insert list of required alarms in first subparagraph below.
 7. Controller connected to alternate power source.
- E. Audible and Visual Alarm and Status Indications: Manufacturer's standard indicating lights;
 1. Engine running.

2. Controller main switch turned to the off or manual position.
 3. Supervised power on.
 4. Common trouble on the controller or engine.
 5. If retaining second option in subparagraph above, insert list of required alarms in first subparagraph below.
 6. Common pump room trouble.
 7. Controller connected to alternate power source.
- F. Audible alarm, with silence push button.
- G. Pump REMOTE START push button.

2.4 LOW-SUCTION-SHUTDOWN PANELS

- A. General Requirements for Low-Suction-Shutdown Panels:
1. Listed by an NRTL for fire-pump service.
 2. Factory assembled, wired, and tested.
 3. Prevents automatic start of fire pump, and shuts down automatically started fire pump, on low-suction pressure.
 4. Automatic reset.
- B. Operation: Integral pressure switch.
- C. Supervisory and Normal Control Voltage: source.
- D. Include audible and visual alarms and status indications, with silence push button, for the following conditions:
1. Control power available.
 2. Low-suction pressure.
 3. Normal-suction pressure.

2.5 ENCLOSURES

- A. Fire-Pump Controllers, ATS, Remote Alarm Panels, and Low-Suction-Shutdown Panels: NEMA 250, to comply with environmental conditions at installed locations and NFPA 20 NEMA-3.
1. Indoor, Dry and Clean Locations: Type 1 (IEC IP10).
 2. Indoor Locations Subject to Dripping Noncorrosive Liquids: Type 2 (IEC IP11).
 3. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12 (IEC IP12).
- B. Enclosure Color: Manufacturer's standard "fire-pump-controller red"
- C. Nameplates: Comply with NFPA 20; complete with capacity, characteristics, approvals, listings, and other pertinent data.
- D. Optional Features:
1. Floor stands, 12 inches (305 mm) high, for floor-mounted controllers.
 2. Space heater, with thermostat.
 3. Tropicalization.

2.6 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect fire-pump controllers according to requirements in NFPA 20 and UL 218.

1. Verification of Performance: Rate controllers according to operation of functions and features specified.
- B. Fire-pump controllers will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

2.7 ELECTRICALLY AND MECHANICALLY INTERLOCKED/ALTERNATING

- A. The transfer switch operation mechanisms are mechanically interlocked to prevent the normal and alternate source from connecting at the same time.
- B. The switch operates upon signal received from its controller.
- C. The panel shall be mounted with multi-function microprocessor based to accurately monitors two power sources and provide the necessary intelligence to reliably operate the ATS through a series of programmed sensing and timing function.
- D. Electrically and mechanically interlock between two controller to avoid running of standby and duty fire pump at the same time. Similar to EATON FT model.

PART 3 - EXECUTION**3.1 EXAMINATION**

- A. Examine areas and surfaces to receive equipment, with Installer present, for compliance with requirements and other conditions affecting performance.
- B. Examine equipment before installation. Reject equipment that is wet or damaged by moisture or mold.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CONTROLLER EXAMINATION

- A. Install controllers within sight of their respective drivers.
- B. Connect controllers to their dedicated pressure-sensing lines.
- C. Wall-Mounting Controllers: Install controllers on walls with disconnect operating handles not higher than 79 inches (2006 mm) above finished floor, and bottom of enclosure not less than 12 inches (305 mm) above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- D. Floor-Mounting Controllers: Install controllers on 4-inch (100-mm) nominal-thickness concrete bases, using floor stands high enough so that the bottom of enclosure cabinet is not less than 12 inches (305 mm) above finished floor. Comply with requirements for concrete bases specified in Division 3 Section "Cast-in-Place Concrete"
 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

- 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- E. Seismic Bracing: Comply with requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- F. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- G. Comply with NEMA ICS 15.

3.3 ATS INSTALLATION

- A. Wall-Mounting ATS: Install ATS on walls with disconnect operating handles not higher than 79 inches (2006 mm) above finished floor, and bottom of enclosure not less than 12 inches (305 mm) above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For ATS not on walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."
- B. Floor-Mounting ATS: Install ATS on 4-inch (100-mm) nominal-thickness concrete bases, using floor stands high enough so that the bottom of enclosure cabinet is not less than 12 inches (305 mm) above finished floor. Comply with requirements for concrete bases specified in Division 3 Section "Cast-in-Place Concrete"
 - 1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
 - 2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base, and anchor into structural concrete floor.
 - 3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 4. Install anchor bolts to elevations required for proper attachment to supported equipment.
- C. Seismic Bracing: Comply with requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

3.4 REMOTE ALARM AND LOW-SUCTION-SHUTDOWN PANEL INSTALLATION

- A. Install panels on walls with tops not higher than 72 inches (1829 mm) above finished floor unless otherwise indicated. Bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For ATS not on walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

3.5 POWER WIRING INSTALLATION

- A. Install power wiring between controllers and their services or sources, and between controllers and their drivers. Comply with requirements in NFPA 20, NFPA 70, and Division 26 Section "Conductors and Cables."
- B. Comply with NECA 1.

3.6 CONTROL AND ALARM WIRING INSTALLATION

- A. Install wiring between controllers and remote devices and facility's central monitoring system. Comply with requirements in NFPA 20, NFPA 70, and Division 26 Section "Control-Voltage Electrical Power Cables."
- B. Install wiring between remote alarm and low-suction-shutdown panels and controllers. Comply with requirements in NFPA 20, NFPA 70, and Division 26 Section "Control-Voltage Electrical Power Cables."
- C. Install wiring between controllers and the building's fire-alarm system. Comply with requirements specified in Division 28 Section "Digital, Addressable Fire-Alarm System."
- D. Bundle, train, and support wiring in enclosures.
- E. Connect remote manual and automatic activation devices where applicable.

3.7 IDENTIFICATION

- A. Comply with requirements in NFPA 20 for marking fire-pump controllers.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification in NFPA 20 and as specified in Division 26 Section "Electrical Identification."

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: EMPLOYER will engage a qualified testing agency to perform tests and inspections.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- D. Acceptance Testing Preparation:
 - 1. Inspect and Test Each Component:
 - a. Inspect wiring, components, connections, and equipment installations. Test and adjust components and equipment.
 - b. Test insulation resistance for each element, component, connecting supply, feeder, and control circuits.
 - c. Test continuity of each circuit.
 - 2. Verify and Test Each Electric-Driver Controller:
 - a. Verify that voltages at controller locations are within plus 10 or minus 1 percent of motor nameplate rated voltages, with motors off. If outside this range for any motor, notify EMPLOYER before starting the motor(s).
 - b. Test each motor for proper phase rotation.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- E. Field Acceptance Tests:
1. Do not begin field acceptance testing until suction piping has been flushed and hydrostatically tested and the certificate for flushing and testing has been submitted to EMPLOYER and authorities having jurisdiction.
 2. Prior to starting, notify authorities having jurisdiction of the time and place of the acceptance testing.
 3. Engage manufacturer's factory-authorized service representative to be present during the testing.
 4. Perform field acceptance tests as outlined in NFPA 20.
- F. Controllers will be considered defective if they do not pass tests and inspections.
- G. Prepare test and inspection reports.

3.9 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.

3.10 ADJUSTING

- A. Adjust controllers and battery charger systems to function smoothly and as recommended by manufacturer.
- B. Set field-adjustable switches, auxiliary relays, time-delay relays, and timers.
- C. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.
- D. Set field-adjustable pressure switches.

3.11 PROTECTION

- A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions until enclosed controllers are ready to be energized and placed into service.
- B. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

3.12 DEMONSTRATION

- A. Engage a factory-authorized service representative to train EMPLOYER'S maintenance personnel to adjust, operate, and maintain controllers, remote alarm panels, and to use and reprogram microprocessor-based controls within this equipment. Engage a factory authorized service representative to train EMPLOYERS' maintenance personnel to adjust, operate, and maintain the engine generator.
- B. Video record all training sessions.

3.13 COMMISSIONING

- A. Refer to Section 210800 "Commissioning" for commissioning requirements.

END OF SECTION