

## SECTION 01 86 13 - PLANT MECHANICAL SYSTEMS AND EQUIPMENT

### 1.01 SUMMARY:

- A. <sup>A16</sup>**Basic Function:** The work under this Section shall include the design, fabrication, delivery, installation and acceptance testing of mechanical systems for the Locks facilities or buildings in strict accordance with applicable standards, regulations and as specified herein. The mechanical systems shall be complete and operational in all aspects and shall comply, but shall not be limited to the following requirements: <sup>A16</sup>
1. Meet all applicable and specified standards and codes
  2. Provide the required durability and reliability in accordance with the applicable and specified standards and codes.
  3. Facilitate maintenance and repair
  4. Enhance safety and health requirements.
- B. <sup>A16</sup>**Section Includes:** The Contractor's work under this Section shall include but shall not be limited to the following: <sup>A16</sup>
1. The Design, fabrication, installation and acceptance testing of the following mechanical systems and equipment:
    - a. Compressed Air Systems
    - b. Air Conditioning Systems and Components
    - c. Mechanical Ventilation Systems
    - d. Passenger Elevator
    - e. Special Purpose Personnel Elevator
    - f. Motorized Capstans
    - g. [Swing and Slide Fence Gate Operators](#)
    - h. Roll-up Doors and Grilles
    - i. Sump Pump Systems
    - j. Electric Motors
    - k. Wet Pipe Sprinkler Fire Protection System
    - l. Standpipe Fire Protection System
    - m. Above Ground Diesel Tanks
    - n. [Overhead Traveling Crane](#)
    - o. Gravity Oil Water Separators
    - p. Plumbing Systems
    - q. Locks Foam Concentrate/Water Fire Protection Systems
    - <sup>A16</sup>r. <sup>A16</sup>Space for Personnel Hoists <sup>A16</sup>

- s. Hydraulic Power Systems
  - <sup>A16</sup>t. (Reserved)
  - u. (Reserved)<sup>A16</sup>
  - v. FM-200 Fire Protection Systems
  - <sup>A7</sup>w. Dewatering Pumps<sup>A7</sup>
2. **Provide the following services, tools and equipment:**
- a. Factory, <sup>A17</sup>pre-commissioning<sup>A17</sup> testing and support
  - b. Training
  - c. Special Equipment and Tools

C. **Related Sections:**

- 1. Section 01 40 00 (*Quality Requirements*).
- 2. Section 01 78 23 <sup>A17</sup> (*Operations Data*).<sup>A17</sup>
- <sup>A17</sup>3. Section 01 91 00 (*Tests On Completion and Tests After Completion*)<sup>A16</sup>
- 4. Section 01 81 36 (*O&M Building and Facilities - Program*)

<sup>A16</sup>**1.02 REFERENCES:**<sup>A16</sup>

- A. **Air Movement and Control Association International (AMCA)**
- B. **American National Standards Institute (ANSI)**
- C. **American Petroleum Institute (API)**
- <sup>A7</sup>D. **American Society for Testing and Materials (ASTM) International**<sup>A7</sup>
- E. **American Society of Sanitary Engineers (ASSE)**
- F. **American Water Works Association (AWWA)**
- G. **Air Conditioning and Refrigeration Institute (ARI)**
- H. **American Institute of Steel Construction (AISC)**
- I. **American Society of Heating, Refrigeration, and Air-Conditioning Engineers, Inc. (ASHRAE)**
- J. **American Society of Mechanical Engineers (ASME)**
- K. **Environment Protection Agency (EPA)**
- L. **Factory Mutual System (FM)**

- M. **International Code Council (ICC) - International Plumbing Code**
- N. **International Safety Equipment Association (ISEA)**
- O. **Manufacturers Standardization Society (MSS)**
- P. **NSF International (NSF)**
- Q. **National Fire Protection Association (NFPA)**
- R. **Occupational Safety & Health Administration (OSHA)**
- S. **Plumbing and Drainage Institute (PDI)**
- T. **Panama Canal Commission Publications**
- U. **Sheet Metal and Air Conditioning Contractors' National Association, Inc. (SMACNA)**
- V. **Steel Tank Institute (STI)**
- W. **Underwriters Laboratories, Inc. (UL)**

### **1.03 REQUIREMENTS:**

- A. **Vibration and Shock:** Equipment and materials shall withstand the effects of random shocks and vibration. All equipment shall be designed to minimize rattling and resonance up to 10 percent above maximum equipment running speed.
- B. **Identification Plates:** Identification plates shall be furnished and installed by the Contractor. The identification plates shall be of noncorrosive metal with clearly legible permanent lettering, giving the manufacturer's name, model number, and the capacity, rating, and other essential information or identification.
- C. **Corrosion Resistance:** Equipment and <sup>A9</sup>systems <sup>A9</sup> shall be designed for a tropical, coastal marine environment. Ferrous metal surfaces other than stainless steel shall be protected in accordance with Section 09 96 00 (*Corrosion Control Coatings*).

### **1.04 DESIGN CRITERIA/SYSTEM DESCRIPTION:**

- <sup>A16</sup>A. **Compressed Air System:** The Contractor shall only design and install the air distribution piping and accessories as specified in this Section. The Contractor shall only specify the air compressors, air dryers, air receivers, and filter dryers; the Employer will purchase and install these components.

1. **Components Designed, Installed and Tested by the Contractor:** The Contractor shall design, install, and test the following:

a. **Compressed Air Distribution Piping:**

Compressed air supply for the Locks facility requires the delivery of air from the source to the user's end with the minimum amount of pressure loss. The Contractor shall limit the losses in the system by properly locating all related components in clusters, thus reducing the connecting pipe lengths and by limiting the use of elbows, reducers and other pipe fittings. Distribution piping shall be ASTM A53 seamless black steel pipe, SCH 80 for underground piping and SCH 40 for exposed aboveground piping. Distribution piping, including pipes, fittings, supports, hangers and valves shall be designed, manufactured, installed and tested in accordance with ASME B31.1. Piping shall include provisions for automatic condensate drain valves at low points in the system.

(1) **External Piping:** External piping shall be limited to a point from the inner wall of a building or lock structure to a suitable valve box with a valve located at least 5 meters from the building.

(2) **Internal Piping and Accessories:** All internal piping and accessories within the building shall be provided.

(3) **Hose Stations:** Shall consist of a 25 mm filter and moisture separator with automatic drain, a 25 mm (1-inch) pressure regulator, and a 20 mm (3/4-inch) quick-change shutoff coupler. Every component of the hose station shall be rated for a maximum pressure of 1,720 kPa (250 psi). Hose stations supplied by suspended pipes shall also include a drip leg.

b. **Distribution Piping Locations:** Compressed air distribution piping shall be available as indicated in the following locations:

(1) **Rolling Gates Machinery Rooms:** Two hose stations per room.

(2) **WSB Conduit Valves Machinery Rooms:** Two hose stations per room.

(3) **Culvert Valves Machinery Rooms:** Two hose stations per room.

(4) **Fire-Fighting <sup>A9</sup>Equipment <sup>A9</sup> Rooms:** Two hose stations per room.

- (5) **Cross-under Tunnels:** One connection at each end of the tunnel to feed the backup pneumatic sump pumps and 4 hose stations evenly distributed along the tunnel for the connection of pneumatic tools.
- 2. **Components to be Designed and Specified Only:** The Contractor shall design the following systems and components only; the construction and testing of these components are not required. The Employer will purchase and install these components.
  - a. **System Design Configuration:** At each location the design shall include a minimum of two compressors operating in tandem each with 50% of the total capacity calculated. These compressors shall supply the demand of the rolling gates machinery rooms, the WSB conduit valves machinery rooms, the fire-fighting equipment rooms, culvert valves machinery rooms, and the cross-under tunnels.
  - b. **Compressed Air System Design:** With the exception of the compressed air distribution piping as specified, the Contractor is not required to construct the compressed air system. The compressed air systems described herein shall be designed to supply the compressed air needs of each building or cluster of buildings in a decentralized manner. The design shall include screw type air compressors, air receivers and distribution systems. The systems components shall be powered by a 3 phase, 60 Hz, electric supply; Voltage to be proposed by the Contractor. The minimum air capacity shall be 120% of the total calculated air load requirements. The air delivered shall be clean, dry and without oils, water or solid contaminants. All components of the system considered as pressure vessels shall conform to ASME BPVC. Air receivers shall carry a certificate with a rating of 860 kPa (125 psi). All components of the compressed air processing systems shall be installed within a suitable building where they will not interfere with the operation or with moving equipment. The air intakes shall be placed and directed in a position to prevent the trapping of solvent vapors, water and other contaminants. The compressed air systems shall be designed and specified for the Canal's tropical marine environment. The minimum accepted pressure at hose stations and other connections will be 700 kPa (100 psi).
  - c. **Air Compressor Specifications:** Each compressor specified shall be a self-contained screw-type module coupled unit complete with drive motor and electrical control-equipment such as a control panel, shutdown alarm / enunciator panel, motor starters, and all other components required for efficient and safe

operation. Air compressors specified meet or exceed the applicable requirements of ISO 5388 and ISO 1217.

- d. **Air Dryers Specifications:** Absorption type air dryers are to be included in the design.
- e. **Air Receivers<sup>A17</sup> Specifications:**<sup>A17</sup> Air receivers rated at 860 kPa (125 psi) minimum are to be included in the design. The air receiver shall be designed equipped with a relief valve set to the compressor maximum pressure and shall be inc. Receivers shall be provided with automatic type drains. Air receivers shall comply with ASME BPVC.
- f. **Filter Dryer Specifications:** Shall be used in the compressed air system to remove most liquid and solid particles from the compressed air. The main filter-dryer shall operate at high efficiency (99%) without a pre-filter and shall be capable of removing particles as small as 0.01 micron; shall have a gauge to indicate time to change element and a drain connection to remove condensate; <sup>A9</sup>1,725 kPa <sup>A9</sup> (250 psig) maximum pressure rating.<sup>A16</sup>

B. **Air Conditioning Systems:** Where specified in Section 01 81 36 (*Operational and Maintenance Buildings and Facilities - Program*), the Contractor shall provide separately zoned, thermostatically controlled air conditioning systems.<sup>A5</sup> Space heating is not required.<sup>A5</sup> The Contractor shall provide adequate air conditioning in these areas as necessary to provide adequate temperature control and air quality in compliance with ASHRAE Standards. In telecommunication rooms, control rooms, and process control systems room, the air conditioning system shall provide also for humidity control in addition to temperature control and air quality. For each facility, the selection between a central air conditioning system and unitary packaged air conditioners or between a chilled water system and a direct expansion system shall be based on energy conservation, life cycle costs, and maintenance considerations as well as functional requirements of the facility and the comfort level in spaces. The building calculations necessary for the design of each building will require the use of computer generated data. Software such as Trane Trace, Carrier HAP, DOE-2.E or other equivalent program shall be used for these calculations. The Contractor shall comply with the following design conditions:

- 1. **Indoor Design Conditions:** The indoor design conditions shall be 23°C (74°F) DB  $\pm$  0.5°C (1°F) and 55% RH maximum for general office spaces. For telecommunication rooms, data centers, or other critical spaces the indoor design conditions shall be in accordance with the recommendations from the ASHRAE Applications Handbook. Provide outside air ventilation to maintain a positive building pressure and to maintain acceptable indoor air quality as required by ASHRAE 62.1.
- 2. **Outdoor Design Conditions:** The outdoor design conditions shall satisfy both sensible design (dry bulb and coincident wet bulb) and latent design (wet bulb and coincident dry bulb) for the Republic of Panama, at

values which are exceeded on average by 0.4% of the total hours of the year, as specified in the ASHRAE Fundamentals Handbook.

3. **Air Conditioning Noise Control:** Acoustical treatment and vibration isolation shall be provided, as required to maintain a maximum sound level within the air conditioned areas in accordance with the requirements of the ASHRAE Applications Handbook.
  4. **Refrigerants:** All equipment with refrigeration systems shall have EPA approved refrigerants.
  5. **Air Conditioning <sup>A9</sup>Equipment:**<sup>A9</sup> All HVAC equipment shall be rated in accordance with the applicable ARI rating program and shall have a minimum EER according to ASHRAE 90.1. Air cooled condensing equipment shall be selected for 35°C (95°F) outdoor air temperature. Air conditioning equipment for telecommunication rooms, data centers, or other critical spaces shall be of the precision air conditioning type.
  6. **Ductwork:** All ducts shall be made from galvanized steel sheets, according to <sup>A9</sup>ASTM A 653, FS, Type A.<sup>A9</sup> The ductwork shall be constructed in accordance with the SMACNA HVAC Duct Construction Standards – Metal and Flexible.
  7. **Refrigeration <sup>A9</sup>Piping:**<sup>A9</sup> Refrigeration piping, valves and accessories shall be in accordance with ASHRAE 15 and ASME B31.5.
  8. **Thermal <sup>A9</sup>Insulation:**<sup>A9</sup> Ducts, pipes and other surfaces within the building whose surface temperatures are expected to fall below the surrounding dew-point temperature shall be insulated in accordance with ASHRAE 90.1. Only fiberglass insulation of the rigid fiberglass board type will be accepted for ductwork.
  9. **Acoustical Insulation:** Internal acoustical duct liner shall be utilized where required to attenuate system noise. The duct liner shall be of rigid fiberglass board type and shall comply with the air-stream surfaces requirements indicated in ASHRAE 62.1.
  10. **Ceiling <sup>A9</sup>Plenums:**<sup>A9</sup> Ceiling spaces shall not be used as return air plenums.
- C. **Mechanical Ventilation Systems:** General ventilation systems shall be in accordance with ASHRAE 62.1. Ventilation systems used at the cross-under tunnels and other confined spaces shall be designed in accordance with OSHA 29 CFR 1926.800. The Contractor shall comply with the following design conditions:
1. **Exhaust/supply <sup>A9</sup>Fans:**<sup>A9</sup> The fans shall be licensed to bear the AMCA seal, and its ratings shall be based on tests and procedures performed in accordance with AMCA Publication 211.

2. **Air Changes:** The required air changes shall be in accordance with the mandatory and advisory requirements of the Manual of the American Conference of Governmental Industrial Hygienists (Latest Edition).
  - <sup>A5</sup>3. **Ductwork:** All ducts shall be made from aluminum sheets, fabricated in accordance with the SMACMA HVAC Duct Construction Standards – Metal and flexible.
  4. **Others:** The same requirements indicated for ductwork, insulation and noise control in the air conditioning <sup>A9</sup>subparagraph <sup>A5</sup> apply.
- D. <sup>A17</sup>**Passenger Elevator:** This specification requires the fabrication, installation, testing and maintenance of a 900 kg (2,000 lb) capacity electric elevator at the control house building. This elevator shall be in strict accordance with ASME A17.1 “Safety Code for Elevators, Dumbwaiters, and Escalators”, ANSI A117, and the Employer's Requirements. The elevator shall be complete with control equipment, automatic floor leveling, automatic car and hoist-way doors and all other equipment necessary for safe and satisfactory operation. The Contractor shall <sup>A9</sup>repair, maintain, and test <sup>A9</sup> the equipment for a period of one year after date of acceptance of the elevator by the Employer’s Representative in accordance with ASME A17.1. The Contractor or the Subcontractor responsible for the elevator, shall be an authorized licensee of the elevator manufacturer, who has not less than 5 years successful experience with the installation of similar elevators, and who maintains a service center within 40 km from the elevator. <sup>A17</sup>
- E. **Special Purpose Personnel Elevator:** This specification requires the furnishing and installing of special purpose personnel elevators at the locks Crossunders. The location and dimensions of the elevator hoistways and car travel shall be reviewed by the Employer’s Representative. The Design and fabrication of each elevator shall be in accordance with ANSI A17.1. Hoistway doors shall not interfere with any fixed equipment or piping located at each landing. The machine room or machine space for the elevator shall be located above the elevator shaft.
1. **Special Purpose Personnel Elevator Schedule:**
    - a. **Minimum Capacity:** 453.6 kg (<sup>A9</sup>1,000 lb <sup>A9</sup>)
    - b. **Car Inside Area:** 1.1 m<sup>2</sup> (10.75 ft<sup>2</sup>) minimum
    - c. **Car Enclosure:** Stainless Steel
    - d. **Hoistway and Car Doors:** Stainless Steel frames and doors at hoistway and car.
    - e. **Pushbuttons:** Waterproof.
    - f. **Car Communication:** Industrial telephone with stainless steel telephone cabinet.
    - g. **ANSI A17.1, Pit Ladder:** Stainless Steel



- h. **Metals and fasteners:** Stainless Steel (Within the pit)
- i. **Other Equipment Provided:**
  - 1) Emergency exit, top of car.
  - 2) Water-proof Limit switches top and bottom of hoist-way
  - 3) ANSI A17.1, stainless steel counterweight guard
  - 4) Pit flood alarm with bell and control
  - 5) Everything else mandatory or advisory or both by ANSI A17.1.
- 2. **Controls:** The control system shall comply with all applicable requirements of ANSI A17.1 and ANSI A17.5. The control system shall be capable of operating the elevator motor in two speeds. Elevator operating devices shall comply with <sup>A17</sup>the Employer's Requirements <sup>A17</sup>and ANSI A17.1.
- 3. **Electrical Classification:** <sup>A7</sup>The equipment shall be suitable for use in a confined-space environment such as the Crossunder tunnels. The equipment shall be explosion-proof, waterproof, stainless steel and dust-tight. The control cabinet shall be NEMA 4X in accordance with NEMA 250. The landing operating stations and pit switch shall be NEMA 6P in accordance with NEMA 250. Also, the limit switches shall be NEMA 6P in accordance with NEMA 250. Electric service shall be 60 Hertz, three phase alternating current, with a voltage to be proposed by the Contractor.<sup>A7</sup>
- 4. The Contractor shall service and maintain the equipment for a period of one year after date of acceptance of the elevator by the Employer's Representative in accordance with ASME A17.1. The Contractor or <sup>A17</sup>the Subcontractor responsible for the elevator, shall be an authorized licensee of the elevator <sup>A17</sup>manufacturer, who has not less than 5 years successful experience with the installation of similar elevators in the area, and who maintains a service center within 40 km of the elevator.
- F. **Motorized Capstan Assembly:** The type, location, capacity, speed, spacing between capstans, and the number of motorized capstans shall require the approval of the Employer's Representative. Each capstan shall be suitable for use in an outdoor, tropical, marine environment. The capstan assembly shall include but shall not be limited to: base, identity plates, capacity plates, brakes, control panel, indicating lamps and all required safety devices.
  - Type:** Vertical axis shaft and drum
  - Number (Minimum):** 4 each per chamber wall, 8 each per locks chamber
  - Spacing between Capstans** 76.2 meters (minimum)
  - Starting Pull (minimum):** <sup>A9</sup>3,000 kg <sup>A9</sup>
  - Line Pull (minimum):** <sup>A9</sup>1,500 kg <sup>A9</sup>

**Line Speed (minimum):** 20 meters / minute

**G. Swing and Sliding Fence Gate Operators:**

1. The swing/sliding fence gate operator shall be a compact heavy duty unit, mounted on a stand, with rigid weatherproof gage housing with ease of access. The unit shall be provided complete with locking provisions. Safety provisions shall consist of a heavy duty type manual emergency release handle, and a rubber bumper all along both edges of the swing/sliding gate operator with limit switch actuation to stop operation in case of meeting an obstruction, sensitivity shall be adjustable. A reversing safety edge shall be provided that would stop and reverse operation should gate encounter an obstruction during closing operation. The limit switches shall provide accurate settings to control "open" and "closed" positions. During manual operations, the limit switches shall remain "timed" to gate position. Fence gate speed shall be not less than 15 mpm (50 fpm). The unit shall be installed on a concrete pedestal not less than 50 mm above the finish grade with bolts as recommended by the manufacturer. Bearings shall be permanently lubricated sealed ball bearing type, except those operating in a lubricant bath. Each gate operator unit shall be in accordance with the manufacturer recommendations as to the proper location to the swing/sliding gate opening and closing direction for proper installation and operation. The operator shall be of the required horsepower, drive and reduction for the particular type and size gate with which it is to be used.
2. **Operational Sequence:** Each fence gate shall be opened and closed from the pushbutton station located in a guard booth or similar manned location where the operator has complete visibility of the gate area. A loop detector shall prevent the inadvertent closing of the gate. The Contractor shall provide all the necessary accessories to prevent the gate from closing while a vehicle has not cleared the gate, and would obstruct the closing of the gate.

**H. Roll-up Doors and Grilles:**

Each new roll-up door or grille unit shall be a complete unit including hardware, accessories, mounting, and installation components. Door shall be steel, spring counter balanced, overhead rolling type and shall be designed for an exterior opening. Complete door assemblies shall include the door curtains, guides, tracks, counter balance mechanisms, hardware, weatherseals and accessories necessary for complete installation. Door or grille shall be face mounted with electric motor and auxiliary manual chain operation. Electric power operated doors shall be complete with electric motors, operators, push buttons, controls, switches, and safety devices. Control equipment shall comply with NEMA ICS.

1. **Operators:** The operator shall be of the horsepower, drive and reduction suitable for the particular type and size and weight door with which it is to be used. Doors shall be provided with an auxiliary chain for immediate emergency manual operation in case of electrical failure. The emergency manual operating mechanism shall be so arranged that it may be operated from the floor without affecting the timing of the limit switches. The hand pull force required to operate the manual operating mechanism shall not exceed 133 Newton (30 lbs).
  2. **Limit Switches:** Operators shall be equipped with switches, an integral part of the mechanism, the limit switches shall provide accurate settings to control up and down positions. During manual operations, limit switches shall remain "timed" to door position.
  3. **Motors:** Motors shall be suitable to the voltage indicated on the Contractor's electrical designs and shop drawings. The Contractor shall be responsible for the verification and coordination of this requirement.
  4. **Reversing Door Safety Edge:** The bottom edge of the door shall have a safety device that shall immediately reverse the door movement upon contact with an obstruction and cause the door to return to its full open position. The safety device shall not substitute for a limit switch. The door shall be provided with a combination compressible weather seal and safety device.
- I. **Sump Pumps Systems:** Sump pump systems shall be designed, constructed and tested at cross-under tunnels and other locations where required. Systems shall include the sump pumps, valves, piping, fittings, hangers, and all the necessary accessories for complete operative installation. Sump pump systems for each cross-under tunnels shall include but shall not be limited to:
1. **Electric Motor Driven Sump Pump**
  2. **Auxiliary Pneumatic Sump Pump:** A backup pneumatic sump pump of equal capacity of the main electric sump pump shall be included in the system design and construction.
- J. **Electric Motors:** The motors shall be designed, manufactured and assembled in accordance with the latest version of NEMA standard MG-1 and applicable ANSI/IEEE standards. Motors operating conditions shall be:
1. 35°C maximum air ambient temperature
  2. 95% maximum relative humidity (non-condensation)
  3. ± 10% rated voltage with rated frequency
  4. ± 5% rated frequency with rated voltage

5.  $\pm 10\%$  combined variation in frequency and voltage (sum of maximum values with frequency variation not to exceed 5%).

K. **Wet Pipe Sprinkler Systems:** <sup>A4</sup>This type of fire protection system shall be installed in facilities where this type of protection is required according to NFPA 101.<sup>A4</sup> The systems shall be designed in accordance with NFPA 13. The wet pipe fire protection sprinkler system shall include but shall not be limited to piping, fittings, valves, sprinklers and all necessary accessories. The system shall be designed with an allowance for future expansion. Computer software NFPA/UL approved shall be used for calculating the hydraulics of the complete distribution system.

1. **Sprinkler Protection Area:** The sprinklers shall be uniformly spaced on the piping system. The maximum allowable protection area for a sprinkler shall be as indicated in NFPA 13. The use of sprinklers in small rooms may not be necessary according to NFPA 101.
2. **Hose Stations demand:** The design shall include provisions to supply the demand of outdoor hose stations in accordance with NFPA 13.
3. **Fire Department Connections Location:** Fire department connections shall be located at least within 30 meters of vehicular access. Fire department connections shall be on the street side of buildings and shall be located and arranged so that hose lines can be readily and conveniently attached to the inlets without interference from any nearby objects, including buildings, fences, posts, or other fire department connections

L. **Standpipe Fire Protection System:** This <sup>A9</sup>Section <sup>A9</sup> includes the installation of Class III wet standpipe and hose systems for fire protection, including piping, valves, hose cabinets, and all necessary accessories for a complete fire protection system. This type of fire protection shall be installed in all the facilities where this type of protection is required according to NFPA 101. The systems shall be designed in accordance with NFPA 14.

M. <sup>A16</sup>**Above Ground Diesel Tanks Design:** Design two Diesel Storage Tanks, one for each lock Complex, as required for the Standby Power Generators in each lock facility.<sup>A16</sup> <sup>A17</sup>The Works shall include the design of the following: steel storage tanks, containment dikes, and piping.<sup>A17</sup>

1. **Steel Storage <sup>A9</sup>Tanks:** <sup>A9</sup> Two welded steel, horizontal, cylindrical tanks complete with all the required fittings, controls, ventilations, piping, valves, manhole, cradle and appurtenances required for a safe and operating <sup>A9</sup>diesel <sup>A9</sup> storage tank.

2. <sup>A16</sup>**Design:** The tanks shall be designed for aboveground storage of diesel fuel in accordance with all applicable provisions of the latest edition of the Underwriters' Laboratories Standard UL 142; however, bearing the UL seal is not a mandatory requirement. The design shall include both tanks and their own concrete containment dike. <sup>A16</sup>
  - a. **Capacity:** The tanks shall be sized in order to provide to the Standby Generators at least 10 hours of uninterrupted diesel supply, with the generators working at full load.
  - b. **Tank location:** The tanks shall be located from the nearest building or facility at least at the minimum distance indicated in NFPA 30.
  - c. **Tank grounding:** Each tank and electrical console shall be grounded in accordance with Section 26 05 26 (*Grounding and Bonding for Electrical Systems*).
  - d. **Corrosion Control:** All ferrous metal shall be protected against corrosion with high performance coatings, resistant to water, weathering, and splash or spillage of diesel, oil and other petroleum products. Coatings shall be in accordance with Section 09 96 00 (*Corrosion Control Coatings*).
3. <sup>A16</sup>**Tank Appurtenances and Accessories:** The design of the tanks shall include all the appurtenances, accessories and controls required in NFPA 30 and UL 142.
4. **Equipment and Piping Design:** <sup>A16</sup>
  - a. **Underground <sup>A9</sup>Piping:** <sup>A9</sup> All underground diesel fuel pipes and fittings shall be double wall flexible piping in accordance with UL 971.
  - b. **Aboveground <sup>A9</sup>Piping:** <sup>A9</sup> Shall be carbon steel pipe, seamless, Schedule 40, with threaded joints, conforming to ASTM A53, Grade B. Fittings shall be black malleable iron, standard weight, threaded ends, conforming to ASTM A197, pressure rating Class 150 and dimensions conforming to ANSI B16.3.
  - c. **Dry Disconnect <sup>A9</sup>Couplings:** <sup>A9</sup> Dry-disconnect couplings shall be provided in the fill pipe of the tanks for the connection of the diesel supply truck hose. The couplings shall consist of a coupler and an adaptor. The coupler shall be attached to the fill hose, and shall contain the open/closed lever and its own valve assembly, consisting of a spring-loaded poppet and disc. The adaptor shall be attached to the fill pipe, and shall contain a poppet assembly, spring-loaded to hold the poppet disc firmly in the closed position until the coupler is attached and the entire assembly is lever actuated. The couplings shall be of aluminum construction, with Buna- seals, 50 mm size.
5. <sup>A16</sup>**Containment Dikes Design:** The actual dike capacity shall be as indicated in UL 142. <sup>A16</sup> The dikes shall include at least two brass gate

valves for the drainage of the dike. The dike floor shall drain towards a sump, where the valves shall be located. The valve outlets shall be above ground external to the dike.

6. <sup>A16</sup>**Piping Design:** Piping design shall be in accordance with NFPA 30.
7. **Fire Prevention and Control Design:** The Contractor shall comply with NFPA 30, which applies to the commonly recognized management techniques and fire control methods used to prevent or minimize the loss from fire or explosion in tank storage facilities. <sup>A16</sup> Qualified engineering judgment shall be exercised.

N. **Overhead Traveling Crane:** Overhead electric traveling (OET) crane and accessories shall conform to CMAA 70 and ASME/ANSI B30.2, Class D, for heavy service, outdoor use and as specified herein. The Contractor shall provide complete overhead electric traveling cranes as required in each facility indicated in Section 01 81 36 (*Operational and Maintenance Buildings and Facilities - Program*). The capacity, speeds and lift of each new OET crane and crane trolley shall be mentioned in the offer. Lift is defined as the distance from the floor level to the highest position of the hook center. The crane capacity shall be selected according to the heaviest piece of equipment/machinery to be handled in each specific facility. The Contractor shall furnish and install each overhead electric traveling crane with bridge, hoist, trolley, motors, brakes, independent pendant pushbutton control, bridge electrification, runway electrification, runway stops, and all accessories for a complete job. Wiring and equipment shall comply with Article 610 of the National Electrical Code. Electrical equipment shall comply with CMAA 70 and ASME/ANSI B30.2 Overhead and Gantry Cranes. The Contractor shall provide electric brakes. All electrically controlled brakes shall be applied automatically when power is interrupted. Limit switches shall be mounted to the Crane Bridge and trolley, respectively, adjacent to one runway rail to interrupt current to the bridge and trolley controls. Adjustable limit switch actuators shall be installed on both ends of those rails to actuate the limit switches and stop the crane bridge or trolley prior to contacting the runway bumpers.

O. **Gravity Oil Water Separators:** The work under this <sup>A9</sup>Section <sup>A9</sup> shall include the design, construction, installation and acceptance testing of gravity oil-water separator systems as required in the Maintenance Buildings of each lock complex, complete with all the required piping, pumps, storage tanks, appurtenances and accessories required for a fully operational oil-water separation system. The oil-water separator shall be designed, constructed and installed in accordance with Stokes Law, API Bulletin No. 421 "Design and Operation of Oil/Water Separators," NFPA 30, UL Standards, and Steel Tank Institute STI-P3 Standard. Oil water separator shall be inspected and tested to verify correct functioning with no leakage of the assembled system before shipment from the factory and after installation at the Locks facility.

P. **Plumbing Systems:** <sup>A7</sup>Plumbing systems for the entire lock facilities shall include, but shall not be limited, to waste, soil, and vent systems; as well as

potable cold and hot water systems, including all piping, fittings, valves fixtures, equipment, and accessories required for a complete operating system. Plumbing elements and facilities required by the Employer to be accessible to the handicapped, shall comply with the applicable provisions of ANSI A117, "Accessible and Usable Buildings and Facilities."<sup>A7</sup>

1. <sup>A7</sup>**Waste, Soil, and Vent Systems:**<sup>A7</sup> Waste, soil, and vent systems shall comply with the requirements of the International Plumbing Code by the International Code Council (ICC).
2. **Potable Hot and Cold Water System:** <sup>A7</sup>The domestic water service shall comply with the International Plumbing Code by the International Code Council (ICC) and shall be sized upon maximum probable demand with an allowance of 15% for future expansion.<sup>A7</sup> The demand shall be based on the fixture requirements signaled for the specific type of occupancy in the International Plumbing Code, unless otherwise indicated in (01 81 36 (*Operational and Maintenance Buildings and Facilities - Program*)). <sup>A7</sup>Where possible, cold water shall be gravity supplied; otherwise, booster pumps shall be used.<sup>A7</sup>
3. Provide isolation valves for branch lines to all plumbing fixtures and equipment. All valve and drain cocks shall be located for ease of maintenance. Valves located behind panels within toilets or other areas shall be clearly identified via appropriate markings on the panel face.
4. Provide proper backflow prevention for mechanical equipment and the service into the buildings as required by the International Plumbing Code and ASME A112.18.3M.
5. Water heaters shall be complete with high temperature water cut-outs and safety relief valves. Discharge points from the safety relief valves shall be to a safe and visible point. Water heaters shall comply or exceed the requirements of NSF Standard 5.
6. **Equipment and Materials:**
  - a. **Materials in Contact with Water:** All materials in contact with raw water or drinking water shall comply with the following:
    - 1) Meet ANSI/NSF Standard 61.
    - 2) Not impact taste or odor to the water nor produce an organic or inorganic content in the water in excess of the maximum level established by applicable standards and codes.
  - b. **Soil, Waste, and Vent Pipes:** Shall be Polyvinyl Chloride (PVC), pressure rated pipe, SDR-26, according to ASTM D 2241. Pipes and fittings shall be fabricated from a PVC compound in accordance with Class 12454-B requirements as defined in ASTM D 1784.
  - c. **Water Piping:** Shall be ASTM B 88 hard drawn copper tubing, type L for aboveground piping and type K for underground

pipings, with bronze or copper fittings approved by the International Plumbing Code. .

d. **Shut-off Valves:**

- 1) **Valves 50 mm (2-inch) and Smaller:** Shall be used on all lines requiring valves to be wide-open or tight shut. Gate valves shall have bronze body, screwed bonnet, rising stem, solid wedge. Gate valves shall have a minimum rating of 860 kPa (125 psi).
- 2) **Valves 65 mm (2-1/2 inch) and Larger:** Gate valves shall be Class 150 ductile iron body, bolted bonnet, outside screw and yoke, solid wedge, bronze trim, raised face flanged ends.

e. **Hose Bibs:** The hose bibs shall have an integral check valve and vacuum breaker to prevent backflow and siphoning action in accordance with ASSE 1014.

f. **Fixtures:** Plumbing fixtures shall be, in general, the product of one manufacturer, if possible, but all fixtures of the same type shall be the products of the same manufacturer. Faucets of all fixtures shall be equipped with a ceramic disc cartridge unless otherwise specified. Plumbing fixtures and appurtenances shall be fastened to the wall with 6-mm (1/4-inch) brass or bronze through or toggle bolts. Fixture trim shall be made by the manufacturer of the fixtures supplied, except when otherwise specified. Exposed metal parts for fixtures shall be chromium plated. The color of plumbing fixtures shall be approved by the Employer's Representative. Fixtures shall be in accordance with the applicable requirements of the International Plumbing Code published by ICC.

- 1) **Water Closets:** Water closets shall be ASME A112.19.2M, white vitreous china, siphon-jet, elongated bowl, equipped with seat without cover. Provide ASME A112.19.5 trim. Provide self-closing metering type flush valve. Handicapped fixture mounting height and appurtenances shall be in accordance with ANSI A117.
- 2) **Lavatories:** Shall be of vitreous china in accordance with ASME A112.19.2M, minimum overall dimensions of 508 mm x 460 mm, lavatory faucet with aerator and pop-up drain, flexible type water supplies, PVC "P" trap, and trap nipple.
- 3) **Lavatories for Handicapped:** Shall be of vitreous china, for wheelchair users, with minimum overall dimensions of 508 mm x 686 mm (20" x 27"), with flexible type water supplies, "P" trap, trap nipple, with brass flange, or equal. Provide ASME 112.18.1M copper alloy centered faucets. The height and



appurtenances shall be in accordance with and ANSI A117.

- 4) **Urinals:** ASME A112.19.2M, white vitreous china, wall-mounted, wall outlet, siphon jet, integral trap, extended side shields. Provide large diaphragm (not less than 66 mm upper chamber inside diameter at the point where the diaphragm is sealed between the upper and lower chambers) flush valve of chrome plated cast brass conforming to ASTM B 584, including vacuum breaker and angle (control-stop) valve. Provide ASME A112.19.5 trim and ASME 112.6.1M concealed chair carriers. Provide self-closing metering type flush valve, unless electronic control is specified in the ESR Section D20. Handicapped fixture mounting height and appurtenances shall be in accordance with ANSI A117.
- 5) **Shower Heads:** Shower heads shall be of the mixing valve type, disc valves or dual control faucets, shower arm, escutcheon, and adjustable spray showerhead.
- 6) **Service Sinks:** ASME A112.19.1M, white enameled cast-iron or ASME A112.19.2M white vitreous china, wall mounted and floor supported by wall outlet corrosion resistant P-trap. Provide ASME A112.18.1M copper alloy back-mounted combination faucets with vacuum breaker.
- 7) **Electric Water Cooler:** Shall be of the wall mounted type with stainless steel cabinet. The cooler shall be selected to properly supply the demand for the specific building/area occupancy. If indicated, it shall also include hot water glass filler.
- 8) **Kitchen Sinks:** Kitchen sinks shall be stainless steel, drop ledge, double compartment, sound dampener, four-hole punch, sized to fit opening, with faucet, supplies for cold water and for hot water, stainless steel crumb cup strainers, PVC "p" trap, and trap nipple.
- 9) **Shower Drains:** Shall have corrosion resistant body and flashing collar and round metallic corrosion resistant adjustable strainer head.
- 10) **Floor Sinks:** Floor sink shall have an acid-resistant interior finish with corrosion resistant body, sediment bucket, and perforated grate in industrial areas and stainless steel in finished areas. The outlet pipe size shall be as indicated or of the same size as the connecting pipe.
- 11) **Twin Eye/Face-Wash:** Twin eye and face wash units shall be designed, constructed and tested in accordance

with ANSI/ISEA Z358.1. Twin heads shall direct a soft stream of water to wash both eyes and face. A universal emergency sign shall be included with each unit. Heads shall be protected with dust covers that remove when water is turned on. Instant-on valve operated by hand and/or foot treadle shall be furnished with the unit. Valve shall stay open until manually closed. Steady water flow under varying pressures shall be assured with a dependable dual automatic pressure compensation device.

- 12) **Emergency Showers:** Floor supported free standing unit. Provide deluge shower head, stay-open ball valve operated by pull rod and ring or triangular handle. The construction and performance of the unit shall conform to ANSI/ISEA Z358.1.

g. **Hot Water Storage Tanks:** The storage tanks shall be the manufacturer's commercially current standard model conforming to ASHRAE 90.1 heat loss coefficient requirements. The construction shall be of the glass lined type, constructed in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code for <sup>A9</sup>1,035 kPa<sup>A9</sup> (150 psi) working pressure.

h. **Other Components:** The design, construction, installation and testing of following materials and components shall be in accordance with the International Plumbing Code by ICC:

- 1) Check Valves
- 2) Pipe Supports
- 3) Dielectric Connectors
- 4) Water Hammer Arresters
- 5) P-Traps
- 6) Plugs for Cleanouts
- 7) Insulation
- 8) Water Heaters
- 9) Circulating Pumps

Q. **Locks Foam Concentrate/Water Fire Protection Systems:**

1. <sup>A16</sup>**General:** The work under this Section shall include but shall not be limited to the design, fabrication, installation, inspection and acceptance testing of a foam/water fire protection system and auxiliary equipment capable of discharging an aqueous film forming foam solution in the event of fire or flammable liquid spill at the lock complex lake and sea entrances.<sup>A16</sup> The foam concentrate system shall protect the lock complex sea entrances, the lake entrances, lock head - 1 (LH-1) including its rolling gates, and lock head - 4 (LH-4) including its rolling

gates. The locks complex shall be protected from fire related heat damage from the entrance lock head (LH-1 or LH-4) to at least the middle of the first chamber. The lock complex sea and lake entrances protected by the foam system shall include but shall not be limited to the approach areas and wing walls. The foam fire protection system is not required for the middle chambers (the chambers between LH-2 and LH-3) of each locks complex and its adjacent gates.<sup>A11</sup> The foam/water fire protection systems shall be complete with all the equipment required for a safe operation, including but not limited to foam concentrate pumps, foam concentrate storage tanks, concentrate controllers, piping distribution systems, piping supports, vibration isolators, releasing stations, discharge nozzles and controls. The fire protection system shall be in accordance with the applicable requirements of NFPA, UL, FM, and ASME.

a. **Equipment at each <sup>A10</sup>Lock Complex Entrance:** <sup>A10</sup>

Each <sup>A10</sup>lock complex entrance chamber <sup>A10</sup> shall be provided with vertical turbine fire pumps, foam pumps, foam storage tanks, oscillating monitor nozzles mounted on towers, foam makers located in the lock walls, fire department connections, electronic alarm and control system, and all associated mechanical, civil, structural, and electrical components/structures. All equipment and materials shall meet as minimum the requirements of and NFPA 11 and NFPA 20.

b. **Piping Distribution System:**

All pipes, fittings, and valves aboveground and within the pump and foam equipment houses, shall be fabricated of stainless steel material. All pipes, fittings, and valves to be installed underground shall be fabricated of ductile iron material. Underground ductile iron pipe shall be cement lined and shall conform to AWWA standards. Underground ductile iron pipes shall be protected against corrosion by means of a polyethylene wrapping conforming to AWWA.

c. <sup>A7</sup>**Control and Communication Systems:**

The control and communication systems shall be as described in Sections 01 81 26 (*Communications, Control, Safety, and Security Systems*).<sup>A7</sup>

2. **Performance Requirements:**

- a. **Scope:** The fire protection system shall be manually activated automatic to discharge aqueous film forming foam solution and water. This type of system shall be constructed to protect the entry areas as well as the first chamber <sup>A10</sup> at each of the lock complexes <sup>A10</sup> so that the potential spill created by impact with the knuckle area would be contained and possibly extinguished by the use of this system before damage could occur to the locks.

- b. **Finished Foam Discharge:** The fire protection system shall be able to discharge aqueous film forming foam (AR-AFFF) solution into the entrances of the lock chambers upon activation of control stations with minimum 15-minute foam duration in the event of flammable-liquid spill or fire. The minimum application rates shall be in accordance with NFPA 11. <sup>A11</sup>The finished foam shall protect the lock complex entrances, LH-1, LH-4, gates at LH-1, and gates at LH-4 from any type of fire related heat exposure. In addition, the locks complex entrance shall be protected from fire related heat damage from the entrance to the middle of the entrance chamber. <sup>A11</sup>
  - c. **Water Discharge:** Also, this system shall be able to provide water by using hydrants located at intervals along the length of each lock wall.
  - d. **Water Intake:** <sup>A10</sup>Water shall be taken from the lake under positive head by a vertical turbine pumps located within each lock wall (east and west). Vertical turbine pumps shall supply water to both the lake entrances and ocean entrances of each lock complex. In the event of a vertical turbine pump failure, a pump on another lock wall shall be capable of supplying water from the lake to both sides by means of inter-connecting piping through the Crossunder tunnels. <sup>A10</sup>
3. **Design:**
- a. **Extinguishing Agents:** Shall be foam solution for nozzles and chambers and water for hydrants. Foam concentrate (AR-AFFF) shall be synthetic type, low expansion, aqueous film forming foam, alcohol resistant, designed to be used in the extinguish of fires involving hydrocarbon petroleum products, polar solvent fuel, or mixtures of hydrocarbon and polar solvents. It shall be transformed into a vapor-blanketing foam when used with fresh, sea, or brackish water and foam generating equipment. Product shall be UL listed for hydrocarbons and polar solvents. Foam concentrate shall be UL listed for at least the following groups of polar solvents: alcohols, ketones, ethers and any new polar solvent family.
  - b. **Remote Control Monitors:** Shall flow water or foam solution with direct-mounted electric actuators or motors. It shall have programmable oscillation capability. The monitors shall be capable to move up and down and from side to side. The monitors shall operate in an automatic mode and in manual mode from a remote location. Monitors shall operate at 480 Volts.
  - c. **Fire Pumps:** Shall be vertical turbine pumps with electric motors. Electric motors shall be of the vertical hollow shaft type, induction type, tropicalized, fungus proof, TEFC rated at <sup>A9</sup>12,000-volt, <sup>A9</sup> 60 Hz, 3-phase. Fire pumps shall comply with NFPA 20. <sup>A7</sup>Testing shall be in accordance with NFPA 20,

- chapter 14 (Acceptance, Testing, Performance and Maintenance).<sup>A7</sup>
- d. **Foam Proportioning System:** Shall include in-line balanced proportioners, positive displacement foam pumps with 460-volt electric motors, piping, valves, tanks, and other accessories.
  - e. **Control Valves:** All valves shall be UL listed for fire protection service.
  - f. **Hydrants:** Hydrants shall be located along the locks walls and as far as possible from locks chambers. The minimum number and average spacing of fire hydrants shall be in accordance with fire flow requirements at the locks.
  - g. **Master Station:** <sup>A7</sup>See Sections 40 00 00 (*Process Systems Integration*), 40 95 13.16 (*Process Control Hardware for Fire Fighting Control Systems*); and 40 96 45.16 (*Process Control Software for Fire Fighting Control Systems*).<sup>A7</sup>
  - h. **Aspirating Nozzles and Foam Chambers:** Shall be provided at the upper and lower ends of the locks walls on both sides.
  - i. **Fire Department Connections:** Fire department connections shall be provided at each locks wall (north and south as a minimum). Connections shall include: foam concentrate, foam solution and water discharges / inlets.
  - j. **Modular Pipe Work:** All pipe work required shall be designed to be assembled using standardized size pipe sections, elbows, reducers, expansion joints and other components as required, with the purpose of reducing the resources required to repair or replace a pipe section and to minimize downtime. No welding shall be required to provide maintenance or repairs to the fire system pipe work. The coupling system for pipe sections and components shall be designed for easy and quick assembly and disassembly. <sup>A7</sup>All pipe diameter sizes, section lengths and elbow angles shall be of standard configuration.<sup>A7</sup> In order to keep a reasonable minimum number of spare stock items in storage, reduce the number of the following items: standard pipe diameter sizes, standard pipe section lengths, and standard elbow angles. All pipe section lengths shall include a standard size connection thread (plug included) for installation of instrumentation sensors, to avoid the need of reworking the replacement part prior to using it. These plugged connection points shall be treated with the same corrosion protection system as the rest of the pipe section both inside and out. The thread specification shall be coordinated with the selection of sensors of the process control system.
  - <sup>A10</sup>k. **Inter-connection of Intake Piping:** The water intake piping of the east wall and the west wall shall be interconnected through the Crossunder tunnels. In the event of a failure of a turbine

pump, a pump on the other lock wall shall be capable of supplying lake water to both sides of the lock complex and subsequently cover the overall water demand.<sup>A10</sup>

4. **Testing:** Upon completion of the installation, the entire system shall be hydrostatically tested and flushed as specified in NFPA 11 and NFPA 20. Water and foam solution discharge tests shall be required to verify design capability of the foam chambers, monitor nozzles, and fire department connections. The foam solution quality tests shall be conducted on each proportioner to determine the correct percentage of foam solution concentrations, expansion and foam retention qualities. The entire system shall comply with NFPA 11. Inspection and <sup>A17</sup>Test on Completion <sup>A17</sup> shall be in accordance with the applicable recommended and mandatory requirements of NFPA.
  5. <sup>A16</sup>**Certification:** A licensed fire protection engineer shall check and approve the installation, test, align, and certify the fire protection systems for operation, and shall instruct the Employer personnel in the operation and maintenance of the equipment and materials.
- R. **Space for Personnel Hoist:** The Contractor shall provide space for 2,177 kg (4,800 lb) capacity electric personnel hoist. (deleted text)<sup>A16</sup>
- S. **Hydraulic Power Systems:** Hydraulic power systems shall be in accordance with the National Fluid Power Association (NFLPA), ASME, SAE, ASTM and equipment manufacturer's requirements for the operating system pressure, fluid type and components used. The design shall be suitable for the severe marine tropical outdoor environment of the <sup>A17</sup>Canal <sup>A17</sup> including the lake and sea entrances. <sup>A7</sup>The hydraulic cylinders, pistons and accessories shall be suitable for underwater use, with exposure to marine life, suspended solids and sea water.<sup>A7</sup> The hydraulic power systems shall be designed to minimize injury to personnel during installation, testing, repairs and maintenance. The Contractor's operating instructions shall include lockout / tag-out procedures in accordance with OSHA requirements. Each hydraulic system operation shall be adjustable for maximum smoothness and shall meet all Contract performance conditions. Components shall include but shall not be limited to:
1. **Hydraulic Cylinders and Accumulators:** Hydraulic cylinders and accumulators shall be designed and manufactured in accordance with the applicable sections of ASME Boiler and Pressure Vessel Code (BPVC).
    - a. **Materials:**
      - 1) **Hydraulic Cylinder Material:** Material for the hydraulic cylinder shall be a high strength carbon or alloy steel.
      - 2) **Piston Rod Material:**
        - (a) Material for the piston rod shall be high-strength, high-chrome stainless steel (chromium weight content of not less than 15.5 %) with a chrome plating thickness of at least 50 micrometers. The surface finish roughness of

the chrome plating shall be less than 0.3 micrometers. The hard chrome plating shall be in accordance with ASTM B 650 and shall be compatible with the piston rod material. For substitute material standards, refer to <sup>A9</sup>Subparagraph 1.02 B. <sup>A9</sup> (*Other Standards*) in this Section.

- (b) The Contractor may propose alternate piston rod materials. If alternate piston rod materials are proposed, the Contractor shall prove that the proposed materials are superior to the specified materials and are applicable to the performance requirements of <sup>A17</sup>the Employer's Requirements. <sup>A17</sup> Prior Employer Representative's approval shall be required for this substitution.

b. **Hydrostatic Testing at Factory:** Each cylinder shall be tested hydrostatically at the factory at 200 percent of the severest service rating.

c. **Design:**

- 1) The Contractor shall provide proof to the Employer's Representative that the dynamic seals are capable of not less than 500,000 cycles of operation in systems properly maintained.
- 2) The hydraulic cylinder shall withstand the maximum operating pressure of the system with a minimum factor of safety of 2 based on the yield strength of the material.
- 3) When designing the hydraulic cylinder, a minimum factor of safety of 3 shall be applied to the compression to resist buckling.
- 4) The hydraulic cylinder tubes (shell) shall be welded in accordance with the applicable requirements of the ASME BPV.
- 5) **Modular Design:** The hydraulic power units shall be designed to facilitate and speed up replacement, repairs and maintenance with a minimum of outage time and adjustment. As much as practical, the hydraulic power systems shall be replaceable as modular units. A modular unit shall be defined as a self-contained unit or independent unit in a construction with configurations that facilitate removal and replacement.
- 6) The minimum frequency of oil replacement shall be 15 years.

- 7) Hydraulic power pack shall be compact and capable of being transported on a wheeled cart for easy replacement.
2. **Hydraulic Oil Monitoring and Warning Devices:** Each hydraulic system shall have hydraulic oil monitoring and warning devices consisting of low, medium and high alarms. Each hydraulic system shall include as a minimum, but shall not be limited to, an in-line particle counter and in-line water detection indicators to assure the required oil cleanness
3. **Pumps:** The pumps of the hydraulic power system shall be furnished complete with electric motor, controls, base, couplings and all necessary components in accordance with the manufacturer's recommendations. The pumps shall be submerged in the hydraulic fluid. A standby pump or other means to provide system operation in the case of breakdown of the main pump shall also be furnished.
4. **Oil Reservoirs:** The oil reservoirs shall be made of stainless steel and shall conform to the requirements of NFLPA. The oil reservoirs shall be a closed rigid type.
  - a. A flexible bladder within the hydraulic reservoir that expands and contracts in response to the withdrawal and return of oil or other means shall be provided to prevent the ingress of air, water, and contaminants.
5. **Hydraulic Test Fittings:** The Contractor shall provide test fittings of the quick release type, in the hydraulic system before and after: pumps, valve bodies and actuators.
6. **Biodegradable Hydraulic Fluids:** Hydraulic fluids shall be biodegradable in accordance with NFPLA requirements and <sup>A17</sup>the Employer's Requirements. <sup>A17</sup> Biodegradable hydraulic fluid shall have equal or better environmental protection properties when compared to Caterpillar "biodegradable hydraulic oil HEES".
7. **Pressure Piping and Pipe Fittings:** Pressure piping and fittings shall be designed, fabricated, installed and tested in accordance with ASME B31.1. All piping, tubing, couplings and fittings shall be made of stainless steel.
8. **Hydraulic Cylinder Positioning System:** The hydraulic cylinder shall have a positioning system with fully redundant measurement capabilities. Measurements of the cylinder stroke position shall be relative to the fully closed position of the valve. The sensor of the positioning system shall be able to recognize the cylinder rod position, and shall be specifically designed to be used with hydraulic cylinders of the type and for the application specified. The design shall include features to facilitate replacement of sensors and accessories with a minimum of down-time.



9. **Other Components:** The Contractor shall include with the design and construction of the hydraulic systems any other required equipment and component such as: gages, thermometers, filters, and valves.

<sup>A16</sup>T. (Reserved)

U. (Reserved)<sup>A16</sup>

- V. **FM-200 Fire Suppression Systems:** The FM-200 fire suppression system shall be an automatic fixed system using FM-200 as the suppression agent. The system shall be designed, manufactured, installed and tested for use in areas containing: communications equipment, electronic data processing, high value or critical equipment, and flammable liquids. All system components shall be new and of current manufacture and shall be designed, fabricated and installed in accordance with the requirements of NFPA standard 2001 (Standard on Clean Agent Fire Extinguishing Systems, 2004 Edition) and these specifications.

1. **Performance Requirements:**

- a. The FM-200 Fire Suppression System shall include a detection and control system with provision for both pre-alarm and automatic agent release. The detection and control system shall employ photoelectric and ionization smoke detectors and heat detectors. A single detector activated shall cause a steady alarm signal to be generated. A second detector activated shall generate a pre-discharge signal and start the pre-discharge condition.
- b. The suppression sub-system shall provide high speed release of FM-200 based on the concept of total flooding fire protection for enclosed areas. A uniform extinguishing concentration shall be seven (7) percent concentration by volume of FM-200 at 70°F, or higher as recommended by the system/agent manufacturers.
- c. FM-200 shall be stored in modular or central storage steel alloy storage containers complying with D.O.T. Specification 4BA or 4BW (Compressed gas containers) or equivalent specification and shall be equipped with differential pressure valves. No replacement parts shall be necessary to recharge the FM-200 containers.
- d. FM-200 shall be discharged through the operation of a solenoid operated device which releases the agent through a differential pressure valve. Systems which employ explosive or pyrotechnic devices shall not be permitted. The system discharge time shall be 10 seconds in accordance with NFPA Standard 2001.

2. **Sequence of Operation:** The system shall be designed and installed such that it is actuated by two detectors in alarm.

- a. Actuation of any one detector.
- b. A steady alarm signal with a 6" vibrating alarm bell.
- c. Annunciate to graphic annunciator panel to indicate location of detector in alarm.
- d. Annunciate to Employer's monitoring equipment.
- e. Perform necessary control functions such as HVAC equipment shutdown.
- f. Shut down and/or keep all emergency generators from starting.
- g. Close all doors leading into protected area.
- h. Actuation of a Second Detector
- i. The steady alarm bell shall silence and an electronic sounder shall provide a pulsed signal.
- j. Annunciate to graphic annunciator panel to indicate location of detector in alarm.
- k. Actuate a time delay with illuminated display. Time delay shall delay release of the FM-200. <sup>A7</sup>The FM-200 shall be released at the end of this time interval unless an abort switch is operated at any time during the interval, in which case, shall reset the time delay and hold at full count. <sup>A7</sup> Upon release of the abort switch, the time delay cycle will resume unless the entire system has been restored to normal by switching the reset switch on the FM-200 control panel.
- l. Actuation of any abort station will cause the audible signal to change, acknowledging proper abort operation.
- m. Discharge of Agent
- n. Energize flashing light suitably labeled.
- o. Annunciate to Employer's monitoring equipment.
- p. Provide a steady output from the electronic sounder.
- q. The system shall be capable of being actuated by manual discharge stations for each protected area. Operation of a manual discharge station shall cause alarm and shutdown devices to operate the same as if the system had operated automatically and shall start the time delay sequence. The FM-200 shall be released at the end of this time delay. Operation of a manual discharge station shall override all abort devices. Refer to Section 28 31 00 (*Fire Alarms for Buildings*).

3. **Design:**

- a. **Components:** Major components of the detection system, cylinders, valves, and releasing devices shall be supplied by one

manufacturer. Components shall be U.L. Listed and/or F.M.  
<sup>A9</sup>approved <sup>A9</sup> as compatible components of a system,  
particularly detection devices, control panels, releasing devices,  
and signaling appliances. Components shall include but shall not  
be limited to:

- <sup>A9</sup>1) Ionization Smoke Detectors <sup>A9</sup>
- 2) Photoelectric Smoke Detectors
- 3) Thermal Detectors
- 4) Manual Release Stations
- 5) Abort Stations
- 6) Graphic Annunciators
- 7) Audible and visual Alarm Devices
- <sup>A9</sup>8) Standby Battery Power <sup>A9</sup>
- 9) Extinguishing Systems
- 10) **Reserve Agent Supply:** The Contractor shall design the suppression system with sufficient amount of the reserve agent necessary to maintain full area protection after the discharge of the primary supply.

4. **Quality Requirements and Workmanship:**

a. **Qualifications:**

- 1) **Manufacturing:** The Manufacturing Company specializing in the products indicated in Section shall have a minimum of three (3) years documented experience.
- 2) **Installers:** The installers shall be trained and certified by the manufacturer to design, install test and maintain clean agent fire suppression systems.
- 3) The Contractor shall have certified special hazard and fire alarm systems designers that are responsible for the development of the FM-200 system.

- b. **Workmanship:** All work including but not limited to fabrication, installation and testing, shall be completed in compliance with current NFPA Standards 2001 and 72. All openings shall be sealed at time of system installation to prevent leakage and maintain system integrity.

5. **Inspections and Tests:** All inspections and tests shall be complete in accordance with current NFPA Standards 2001 and 72.

- a. <sup>A17</sup>**Tests on Completion:** The Tests on Completion <sup>A17</sup> shall be conducted in the presence of the Employer's Representative. Tests shall demonstrate that the entire control system functions as intended. All circuits shall be tested: Automatic discharge, manual discharge, equipment shutdown, alarm devices, and storage container pressure. In addition, supervision of each circuit shall be tested. Each detection device shall be tested according to the manufacturer's recommended procedures of NFPA 72.
- b. Room integrity tests shall be conducted. Tests shall be conducted by the Contractor, FM-200 equipment manufacturer or FM-200 manufacturer's representative in the presence of the Employer's Representative. Such tests shall be made only after the control system has tested satisfactorily. The manufacturer of the test equipment shall provide a specification for the room integrity test. An inspection shall be made by the FM-200 distributor to ensure that all required dampers, door bottom seals, weather-stripping, caulking, and foam sealant have been installed and that the areas protected shall, in fact, contain the FM-200 for the full ten minutes required. The responsibility for this work shall lie with the Contractor. <sup>A7</sup>The responsibility for determining the corrective action required is that of the Contractor and FM-200 system installer and shall not relieve the Contractor of his obligation to conduct any required retests of the system at no cost to the Employer should the test fail due to inadequate room tightness, faulty design, installation, or equipment failure. <sup>A7</sup> The Contractor will provide the Employer with a complete operation and maintenance manual as well as a written summary of any functional tests conducted
- c. The piping shall be pneumatically tested in a closed circuit for a period of 10 minutes at 150 psig. At the end of 10 minutes, the pressure drop shall not exceed 20 percent of the test pressure. When pressurizing the piping, pressure shall be increased in 50 psig increments. A flow test using nitrogen shall be performed on the piping network to verify that flow is continuous, and the piping and nozzles are unobstructed.

6. <sup>A17</sup>**Maintenance Services:** After the Taking-Over Certificate of the Works, the Contractor shall service and maintain the equipment in accordance with Section 01 93 00 (*Maintenance Services*). <sup>A17</sup>

- <sup>A7</sup>W. **Dewatering Pumps:** The locks chambers, Water Saving Basins, locks gate Recesses, valve pits, culverts and conduits, shall be designed to be dewatered by gravity and/or pumping. Dewatering pump systems shall include electric motor

driven pumps, electric motor starters, valves, piping, fittings, hangers, and all the necessary accessories for complete installation and operation.<sup>A7</sup>

**1.05** <sup>A16</sup>**SUBMITTALS:** Whenever data, as required below, is for the review of the Employer's Representative, the results of the review will be communicated to the Contractor within 28 days of receipt of the required data.<sup>A16</sup>

**A. Preliminary Design Data:** Within 182 days of the Commencement Date, prior to the procurement of materials or equipments, the Contractor shall submit to the Employer's Representative for his review, 5 sets of design data including the Quality Control Plan, its procedure for identifying and resolving non conformances, and the documented non conformances.<sup>A16</sup> The preliminary design, data shall include but shall not be limited to:

**1. Design Analysis:** The design analysis shall include a written explanation of the system design and equipment selection. It shall contain a summary of the criteria including codes, references and safety requirements. The justification for each major selection and design decision shall be clearly stated, and include supporting calculations, when applicable.

**2. Design Data:** The data shall contain the general arrangement, calculations, critical dimensions and overall dimensions. The data shall include the electrical and mechanical systems and their main components. It shall provide the location of major components.

**B. Final Design Data:** Within 728 days of the Commencement Date and after completion of the design and prior to the procurement of materials or equipments, the Contractor shall submit to the Employer's Representative for his review, 5 sets of final design data.<sup>A16</sup> The final design data, shall include but shall not be limited to:

**1. Final Design Analysis:** The design analysis shall include a written explanation of the system design and equipment selection. It shall contain a summary of the criteria including codes, references and safety requirements. The justification for each major selection and design decision shall be clearly stated, and include supporting calculations, when applicable.

**2. Final Design Drawings:** Final design drawings shall be of high quality and complete to permit the Employer a thorough evaluation of the technical design solutions provided for the proposed exhaust systems. The final drawings shall include but not be limited to the general arrangement of equipment, distribution devices, piping, isometric diagrams, equipment schedule, notes, sections and all necessary details deemed necessary for the construction of the systems.

- C. **Final System Detail Drawings:** The Contractor shall submit to the Employer's Representative, drawings showing the general arrangement of equipment, distribution devices, piping, isometric diagrams, equipment schedule, notes, sections and all necessary details deemed necessary for the construction of the systems.
- D. **Material and Equipment Schedules:** A complete schedule of materials and equipment proposed for installation shall be submitted by the Contractor for <sup>A9</sup>review. <sup>A9</sup> The schedule shall include model numbers, cuts, diagrams, drawings, fan curves, materials, cooling capacity, painting information, and such other descriptive data as may be required. No consideration will be given to partial lists submitted from time to time. Favorable review of materials will be based on manufacturer's published ratings. Materials and equipment listed which are not in accordance with the specification requirements will be rejected.
- E. <sup>A16</sup>**Shop Drawings:** As soon as practicable after the Commencement Date and before starting installation of any materials or equipment, plans and elevations of equipment layout showing proposed equipment location, piping, and applicable appurtenances thereof, with clearances and schematic control and wiring diagrams, shall be submitted for review. <sup>A16</sup>
- F. **Certifications:** Certificate from the equipment manufacturer shall be submitted certifying that the performance rating of the equipment comply with the specified standard's ratings and the unit design conforms to appropriate UL Standards.
- G. **Testing Program:** The proposed testing program shall be submitted to the Employer's Representative at least two weeks prior to the scheduled test to assure agreement as to personnel and instrumentation required and the scope of the testing program.
- H. **Reports:** Reports containing all field data collected during the adjustments and testing of the system. These reports shall contain all the information required by the applicable standards.
- I. **Instruction Books, Spare Parts List, Inventory List, and List of Special Tools:** Nine copies, in English and Spanish, of the instruction books, spare parts list, inventory list, and list of special tools shall be submitted no later than the date the equipment is shipped from the factory.
1. **Instruction Books:** Instructions shall be suitably bound to withstand normal use by operating personnel. Prints of drawings necessary for a clear understanding of the written instructions shall be included with the instructions. Prints which are too large for binding shall be placed in print pockets or envelopes which, in turn, shall be bound into the instruction books. The instruction books shall include the following:

- a. Detailed description of the function of each principal component of the equipment together with drawings and data showing the parts of the assembly, with exploded views, where necessary, to clearly indicate the procedure to be followed.
  - b. Installation, adjustment, operation, maintenance, and overhaul instructions.
  - c. Lubrication schedule, including type, grade, and temperature range, and frequency.
  - d. Safety precautions, schematic control and wiring diagrams, and illustrations. A control sequence describing start-up, operation, and shutdown is also required.
  - e. Procedure in the event of equipment failure.
  - f. Test procedures and performance test reports, including records of readings.
  - g. Any other necessary items of instruction recommended by the manufacturer of the equipment.
2. **Spare Parts List:** A complete spare parts list, including parts number and description or the name of each part, together with drawings of the equipment and exploded views of sections and assemblies showing the location of the part in the unit by number, shall be submitted for <sup>A9</sup>review. <sup>A9</sup>
3. **Spare Parts Inventory:** A recommended one-year spare parts inventory with prices for the equipment. These parts shall not be included in the Contract price. Spare parts normally needed during start-up or initial operation of the equipment shall be furnished.
4. **List of Special Tools:** A recommended list of special tools required for routine maintenance, inspection, and field repairing of each item of equipment. Special tools which are normally furnished with the equipment shall be supplied at no additional cost to the Employer. Special recommended tools which are not normally supplied with the equipment shall be listed separately with the current cost for each item. These tools shall not be included in the Contract price.
5. **As Built Reproducible Drawings:** Prior to <sup>A17</sup>the Taking-Over Certificate for the Works, <sup>A17</sup> the drawings shall be revised by the Contractor to show any deviations of the actual construction from the work indicated in the Contract drawings and these revised reproducible drawings shall be submitted to the Employer's Representative.

## 1.06 QUALITY ASSURANCE:

### A. Workmanship:

1. **Equipment:** Shall be installed according to the manufacturer's recommendations. The Contractor's installer shall be an authorized licensee of the manufacturer, who has not less than 5 years successful experience with the installation and testing of similar equipment.
2. **Ductwork:** Shall be installed in accordance with the SMACNA HVAC Duct Construction Standards - Metal and Flexible.
3. **Piping:** Shall be installed in accordance with ASHRAE 15 and ASME B31.5.

### B. Defective Equipment: <sup>A7</sup>Defective equipment or equipment damaged in the course of installation or testing shall be replaced or repaired by the Contractor in a manner approved by the Employer's Representative, at no additional cost to the Employer.<sup>A7</sup>

### C. Testing: Tests shall be conducted in the presence of the Employer's Representative who shall be given <sup>A9</sup>21 days<sup>A9</sup> notice before any test is to be conducted. Water and electricity required for the tests will be furnished by the Contractor. Materials, equipment, instruments, and personnel required for the tests shall be provided by the Contractor.

### D. Operating and Maintenance Instructions: <sup>A9</sup>Complete <sup>A9</sup> piping, wiring, and control diagrams of the system, framed under glass, shall be posted at a location designated by the Employer's Representative. Operating instructions explaining preventive maintenance procedures and methods for safe starting and stopping of the system shall be prepared in typed form, framed under glass, and posted beside the wiring and control diagram.

### E. Demonstration: Upon completion of installation, the Contractor shall assign a representative from the installing <sup>A17</sup>Subcontractor or manufacturer to instruct the Employer in the operation and maintenance of the equipment. Requirements in related Section 40 00 00 (*Process Systems Integration*); Section 01 78 23 (*Operations Data*); and Section 01 91 00 (*Tests on Completion and Tests after Completion*), shall apply.<sup>A17</sup>

## END OF SECTION