SECTION 22 1000 – PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Self-Priming Sewage and Sump Pumps - With Four Solid State Level Switches.
2. Self-Priming Sewage and Sump Pumps - With Dual Level Switches.
3. Domestic Water Booster Pump Systems - High Pressure (Above 100 psi).
4. Domestic Water Booster Pump Systems - Low Pressure (100 psi maximum).
5. Electric Water Coolers.
6. Duplex Sump Pumps Systems - Duplex - Submersible Vortex or Semi-Open - 2 Digital Level Switches.
7. Duplex Sump Pumps Systems - Submersible Vortex - 2 Digital Level Switches.

B. Related Sections:

1. Section 22 1118 “Domestic Water Distribution System.”

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, including dimensions, rough-in and connection requirements, and electrical data.

1.3 INFORMATIONAL SUBMITTALS

A. Factory Test and Certification: for each system identified.

B. Witness Signature: documentation that an NU FMO staff member witnessed the domestic water flushing.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

B. Northwestern University Maintenance Requirement Forms, see division 01 for more information.

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. UL Compliance: Comply with UL 778 for motor-operated water pumps.

C. Comply with requirements of NSF-61 and 372 as applicable to each type of pump system.

1.6 REFERENCE STANDARDS

A. The work in this section is subject to the requirements of applicable portions of the following standards:

1. HI - Hydraulic Institute
2. ANSI – American National Standards Institute
3. ASTM – American Society for Testing and Materials
4. IEEE – Institute of Electrical and Electronics Engineers
5. NEMA – National Electrical Manufacturers Association
6. NEC – National Electrical Code
7. UL – Underwriters Laboratories, Inc.
8. NSF - National Sanitation Foundation

PART 2 - PRODUCTS

2.1 Provide independently fed power supplies to each pump. Locate each power supply on its own separate breaker. Provide each panel with self-latching relays to respond in the event of a single power failure.

2.2 SEWAGE EJECTOR AND SUMP PUMP SYSTEMS – DUPLEX – SELF-PRIMING - WITH FOUR SOLID STATE LEVEL SWITCHES

A. Provide self-priming sewage or sump pump systems, with four (4) digital level switches, of the sizes and capacities as noted on the drawings.

B. The pumps shall be duplex, self priming type designed for floor-level installation above the wet-well. The pumps shall be designed to facilitate pump maintenance and volute-cleaning above the wet-well, in a clean, dry and safe environment. Pump designs which require personnel to enter the confined-space of the wet-well for any reason, or lift equipment weighing many hundreds of pounds out of the wet-well for servicing, are not acceptable.

C. The pumping systems shall be as manufactured by Metropolitan Industries, of Romeoville, IL., and shall include two self priming sump pumps with close-coupled motors, mounted on an epoxy-coated steel basin cover provided with suction pipe openings, inspection-opening and suspension devices for the level controls.

D. The system shall be designed such that no equipment is installed below the basin-cover, other than the suction-pipes, vent-pipe, and four (4) solid-state level switches with stainless-steel mounting-chain & anchor, all of which shall be suspended from the cover.

E. Pump construction and design.

1. The pumps shall be capable of passing solids of the sizes indicated on the contract drawings. The impeller and removable volute lip-plate shall be constructed of ductile-iron. The complete pump rotating unit which includes the motor, motor mounting bracket, mechanical seal, replaceable volute-lip and impeller shall be removable as a one-piece unit, back-pull-out design, without disturbing the suction or discharge piping.
2. The impeller shall be of the enclosed type, with pump out vanes on both the front and the back shroud. The pump units shall include bronze case wear rings, and removable

casing access covers, so that all parts of the pump suction-case, including the impeller port, shall be accessible for cleaning and inspection.

3. The pump casing shall be designed so that sufficient liquid is retained in the casing to re-prime the pump. The pump shall include an integral removable suction flap-valve, and shall be capable of re-prime, even if solids become lodged under suction flap-valve, causing liquid to drain back to the wet-well when the pump is idle.
4. The pump shall be provided with a vacuum-rated grooved-coupling, attached to the suction-elbow, for connection to the grooved-end suction pipe.

F. Close-coupled motor.

1. Each pump shall be driven by a NEMA Premium-Efficiency motor to keep pace with EISA protocols. The motors shall have a totally-enclosed fan-cooled (TEFC) enclosure with a 1.15 service-factor. Each pump must operate within the nameplate horsepower of the motor at all points along the entire pump capacity head curve beyond the duty-point condition, reserving the available service factor of the motor as a safety-factor.
2. Performance curves which extend into the service (safety) factor, beyond the nameplate horsepower line at any point, are not acceptable.

G. Control panel.

1. Provide a single enclosure power and control panel (NEMA 1). The enclosure shall be steel, and finished with an oven baked enamel. The panel shall include a door-interlocked through-the-door safety disconnect switch. The control panel shall have the UL listing mark for industrial control panels, and shall include a microprocessor-based process-controller. Relay-based control systems, which do not allow the flexibility of being re-programmed in the field, are not acceptable.

    a. The internal portion of the control panel shall include one (1) 3-phase power-distribution block, two (2) 3-phase thermal magnetic circuit breakers, two (2) across the line starters, and two (2) adjustable class-10 overload-blocks. The enclosure shall also house all other necessary control components, including but not limited to one (1) control-circuit transformer with separately-fused primary, and secondary, microprocessor-based process-controller, as specifically referenced below.
    b. The process-controller shall include an on-board 24vac control-circuit transformer, to provide low-voltage power to the level-switches.
    c. The process-controller shall be designed with the following fail-safe operational features and indicators:

        1) If one, two, or as many as three of the four wet-well level-switches become inoperable, the fail-safe self-diagnostic logic controller shall be designed to continue uninterrupted automatic operation of one or both pumps, and all alarms & faults.

    d. The process-controller shall include the following indicators:

        1) One (1) power-on light
        2) Two (2) pump-run lights
        3) Two (2) pump-fail lights
        4) Two (2) contactor feedback status lights
        5) Two (2) seal-fail lights (when applicable)
        6) Four (4) level-switch status lights
        7) One (1) alarm code light to display seven (7) flashing fault codes

8) One (1) flashing high wet-well level alarm light

e. The control panel shall include the following devices, for use in remotely monitoring the system:

1) Two (2) sets: pump seal-fail digital dry alarm contacts (when applicable).
2) One (1) set: high wet-well level digital dry alarm contacts.

f. The process-controller shall perform the following major functions:

1) Start and stop 1-pump during normal flow conditions.
2) Start and stop 2-pumps during extreme flow conditions.
3) Alternate two pumps on successive cycles of operation.
4) Monitor & delay pump-starts to avoid short-cycling motors.
5) Monitor & delay pump-starts to avoid simultaneous starting of pumps following utility power losses.
6) Monitor & recognize inoperable level-switches, and modify system operation to compensate for this occurrence.
7) Provide easily identifiable alarm codes for the operating personnel to monitor.
8) Include separate fuses for each contactor circuit, as well as each alarm circuit.
9) Monitor embedded pump-motor thermal-sensors, when wired.
10) Provide a reverse bump switch on each pump.

2. The control system shall be provided with a Metropolitan “Metro-Mail”, messaging system, designed to monitor and report the status of the equipment to key personnel, during regular and/or emergency situations. The unit shall be capable of sending e-mail messages or text messages through an internet connection. The equipment control system shall include singular or multiple remote alarm contacts as designated within the equipment control system specifications. These shall be factory pre-wired to the Metro-Mail messaging system, each powered by a 10-to-30 volt ac-or-dc power supply. The messaging system shall include eight (8) electrically-separated, optically-isolated digital inputs. Each pair of input terminals shall include a red led-indicator light, which shall illuminate when the circuit is energized. The messaging system shall also include a single led-indicator status-light. This light shall glow-green to indicate that the unit is powered and is properly configured; and shall flash to indicate that an e-mail is being transmitted. The led-indicator shall glow-amber to indicate that the unit is booting, or to indicate that an ip-number has not been assigned. An ethernet port shall be provided, to allow connection of the unit to an internet connection, using a standard or crossover ethernet cable. The Metro-Mail shall include an on-board web-server, allowing the user to configure messages; e-mail addresses; and other settings, via a standard web browser. The Metro-Mail shall be powered through the main equipment control system, via a 10-to-30 vac/dc power supply.
3. Control systems without all of the essential fail-safe operational features, lights, fault-codes, indicators, and remote-monitoring devices listed above are insufficient for the intended service, and are not acceptable.
4. Provide BAS options on panel or extra connection points for future BAS connection. Confirm requirements with NU.

H. Liquid level sensors.

1. Provide four (4) suspended solid-state digital level-switches, of the strain-gauge type, designed with no moving parts. Mechanically operated switches, which are more

susceptible to failure, are not acceptable. Cord grips fastened to the basin-cover shall be used to support the level-switch cords. The switches shall be fastened to a stainless-steel chain with anchor, in such a way that allows level-adjustment of the switches from above the basin cover. These level-switches shall be used to control & monitor liquid level in the wet-well.

2. The switch installed in the lowest position shall shut off all pumps. The next switch from the bottom will start one pump and shall trigger alternation of the pumps on each successive cycle of operation. The third switch from the bottom shall start both pumps or start the second pump if the first pump fails for any reason.
3. The fourth switch shall be located at the highest point, at the invert of the basin inlet, and shall signal a high wet-well level alarm. All level-switches shall be removable through the basin cover.

I. Field installation requirements.

1. A suction pipe shall be provided by the contractor and installed on each pump. The suction pipe must be of 1-piece construction, and shall be schedule-80 PVC, galvanized steel, or iron pipe. The size of the pipe shall be the same size as the pump suction connection. The suction pipes shall be installed air tight. The bottom end of the pipe shall be installed to a point measuring 6"-to-8” from the wet well floor.
2. An appropriate sewage-type check-valve shall be provided by the contractor and shall be installed in the discharge line of each pump. An appropriate gate-valve or plug-valve shall be provided by the contractor and shall be installed downstream of the check-valve.
3. A small diameter air vent line & isolation-valve shall be provided by the contractor & installed on each pump, per the manufacturer’s instructions. It shall be designed to evacuate any air on the discharge side of the pump-impeller, between the pump discharge nozzle and the discharge check valve. The outlet of the air vent line shall discharge into the wet well through the basin-cover. The line shall extend from the basin-cover, down into the wet-well, and must terminate below the liquid-level, but no lower than a point 6”-to-8” above the bottom of the suction pipe. Galvanized tubing is not acceptable for this air vent line or suction pipe.

J. Qualification Of Equipment Manufacturer:

1. In order to establish a standard of quality and to insure a uniform basis of bidding, the system shall be manufactured by Metropolitan Industries, Inc., or a prior written approval equal, approved by FMDC and FMO plumbing staff. To be considered an approved equal, complete details and shop drawings must be submitted to the engineer no later than ten (10) days prior to the bid date. Sufficient data must be submitted so that the engineer has the required information available to determine whether the alternate system meets the requirements of the specifications. The contractor shall prepare his bid on the basis of the specific system specified for purposed of determining the low bid. After the execution of the contract, substitution of non-specified equipment will be considered, if the substitution is, in the opinion of the engineer, equal in quality, substance, and performance to the named manufacturer. If such substitution is approved by the engineer, all savings affected by the contractor in the purchase of the substituted equipment shall be passed on to the owner by reducing the contract price. In submitting for substitution, the contractor shall provide certified copies of equipment proposals from the named manufacturer, as well as the substitute manufacturer.
2. The equipment manufacturer shall furnish 24 hour service for the complete system, and shall stock all integration parts used for the installation.

K. Start Up Service:

1. The service of a factory trained representative shall be made available on the jobsite for one (1) six-hour period of time, to verify proper installation of the system, provide start up, and adjustment, and provide instructional operational training for the operator's personnel.

2.3 SEWAGE EJECTOR AND SUMP PUMP SYSTEMS – DUPLEX – SELF-PRIMING - WITH DUAL LEVEL SWITCH ASSEMBLY FLOATS

A. Provide self-priming sewage or sump pump systems, with pedestal-mounted mechanical-alternator level switch assembly, of the sizes and capacities as noted on the drawings.

B. The pumps shall be duplex, self-priming type designed for floor-level installation above the wet-well. The pumps shall be designed to facilitate pump maintenance and volute-cleaning above the wet-well, in a clean, dry and safe environment. Pump designs which require personnel to enter the confined-space of the wet-well for any reason, or lift equipment weighing many hundreds of pounds out of the wet-well for servicing, are not acceptable.

C. The pumping systems shall be as manufactured by Metropolitan Industries, of Romeoville, IL., and shall include two self-priming sump pumps with close-coupled motors, mounted on an epoxy-coated steel basin cover provided with suction pipe openings, inspection-opening and suspension devices for the level controls.

D. The system shall be designed such that no equipment is installed below the basin-cover, other than the suction-pipes, vent-pipe, and two (2) level switch assembly floats, all of which shall be suspended from the cover.

E. Pump construction and design.

1. The pumps shall be capable of passing solids of the sizes indicated on the contract drawings. The impeller and removable volute lip-plate shall be constructed of ductile-iron. The complete pump rotating unit which includes the motor, motor mounting bracket, mechanical seal, replaceable volute-lip and impeller shall be removable as a one-piece unit, back-pull-out design, without disturbing the suction or discharge piping.
2. The impeller shall be of the enclosed type, with pump-out vanes on both the front and the back shroud. The pump units shall include bronze case wear rings, and removable casing access covers, so that all parts of the pump suction-case, including the impeller port, shall be accessible for cleaning and inspection.
3. The pump casing shall be designed so that sufficient liquid is retained in the casing to re-prime the pump. The pump shall include an integral removable suction flap-valve, and shall be capable of re-prime, even if solids become lodged under suction flap-valve, causing liquid to drain back to the wet-well when the pump is idle.
4. The pump shall be provided with a vacuum-rated grooved-coupling, attached to the suction-elbow, for connection to the grooved-end suction pipe.

F. Close-coupled motor.

1. Each pump shall be driven by a NEMA Premium-Efficiency motor to keep pace with EISA protocols. The motors shall have a totally-enclosed fan-cooled (TEFC) enclosure with a 1.15 service-factor. Each pump must operate within the nameplate horsepower of the motor at all points along the entire pump capacity-head curve beyond the duty-point condition, reserving the available service factor of the motor as a safety-factor.
2. Performance curves which extend into the service (safety) factor, beyond the nameplate horsepower line at any point, are not acceptable.

G. Control Panel

1. Provide a single enclosure power and control panel (NEMA 1). The enclosure shall be steel, and finished with an oven-baked enamel. The panel shall include a door-interlocked through-the-door safety disconnect switch. The control panel shall have the UL listing mark for industrial control panels, and shall include a microprocessor-based process-controller. Relay-based control systems, which do not allow the flexibility of being re-programmed in the field, are not acceptable.

   a. The internal portion of the control panel shall include one (1) 3-phase power-distribution block, two (2) 3-phase thermal magnetic circuit breakers, two (2) across the line starters, and two (2) adjustable class-10 overload-blocks. The enclosure shall also house all other necessary control components, including but not limited to one (1) control-circuit transformer with separately-fused primary, and secondary, microprocessor-based process-controller, as specifically referenced below.
   b. The process-controller shall include an on-board 24vac control-circuit transformer, to provide low-voltage power to the level-switches.
   c. The process-controller shall be designed with the following fail-safe operational features and indicators:

      1) If the mechanical float alternator becomes inoperable, the fail-safe self-diagnostic logic controller shall be designed to continue uninterrupted automatic operation of one or both pumps, and all alarms & faults.

   d. The process-controller shall include the following indicators:

      1) One (1) power-on light
      2) Two (2) pump-run lights
      3) Two (2) pump-fail lights
      4) Two (2) contactor feedback status lights
      5) Two (2) seal-fail lights (when applicable)
      6) Four (4) level-switch status lights
      7) One (1) alarm light to display three (3) flashing fault codes
      8) One (1) flashing high wet-well level alarm light

   e. The control panel shall include the following devices, for use in remotely monitoring the system:

      1) Two (2) sets: pump seal-fail digital dry alarm contacts (when applicable).
      2) One (1) set: high wet-well level digital dry alarm contacts.

   f. The process-controller shall perform the following major functions:

      1) Start and stop 1-pump during normal flow conditions.
      2) Start and stop 2-pumps during extreme flow conditions.
      3) Alternate two pumps on successive cycles of operation.
      4) Monitor & delay pump-starts to avoid short-cycling motors.
      5) Monitor & delay pump-starts to avoid simultaneous starting of pumps following utility power losses.
      6) Monitor & recognize inoperable level-switches, and modify system operation to compensate for this occurrence.
      7) Provide easily identifiable alarm codes for the operating personnel to monitor.

8) Include separate fuses for each contactor circuit, as well as each alarm circuit.
9) Monitor embedded pump-motor thermal-sensors, when wired.

2. The control system shall be provided with a Metropolitan “Metro-Mail”, messaging system, designed to monitor and report the status of the equipment to key personnel, during regular and/or emergency situations. The unit shall be capable of sending e-mail messages or text messages through an internet connection. The equipment control system shall include singular or multiple remote alarm contacts as designated within the equipment control system specifications. These shall be factory pre-wired to the Metro-Mail messaging system, each powered by a 10-to-30 volt ac-or-dc power supply. The messaging system shall include eight (8) electrically-separated, optically-isolated digital inputs. Each pair of input terminals shall include a red led-indicator light, which shall illuminate when the circuit is energized. The messaging system shall also include a single led-indicator status-light. This light shall glow-green to indicate that the unit is powered and is properly configured; and shall flash to indicate that an e-mail is being transmitted. The led-indicator shall glow-amber to indicate that the unit is booting, or to indicate that an ip-number has not been assigned. An ethernet port shall be provided, to allow connection of the unit to an internet connection, using a standard or crossover ethernet cable. The Metro-Mail shall include an on-board web-server, allowing the user to configure messages; e-mail addresses; and other settings, via a standard web browser. The Metro-Mail shall be powered through the main equipment control system, via a 10-to-30 vac/dc power supply.
3. Control systems without all of the essential fail-safe operational features, lights, fault-codes, indicators, and remote-monitoring devices listed above are insufficient for the intended service, and are not acceptable.
4. Provide BAS options on panel or extra connection points for future BAS connection. Confirm requirements with NU.

H. Liquid level sensors.

1. Provide one (1) pedestal-mounted mechanical float-alternator assembly with stainless steel float-ball, float-rod, and rod-stops, as well as one (1) suspended mechanical alarm level-switch, which shall be used to control & monitor liquid level in the wet-well. The level-switches shall be installed in such a way that they allow level-adjustment of the switches from above the basin cover.
2. The mechanical alternator switch indexed in the lowest position shall shut-off all pumps. The next-highest indexed position shall start one pump, and shall trigger alternation of the pumps on each successive cycle of operation. The third and highest indexed position shall start both pumps or start the second pump if the first pump fails for any reason.
3. The suspended mechanical alarm level-switch shall be located at the highest elevation of all wet-well inlet elevations, and shall signal a high wet-well level alarm. All level-switches shall be removable through the basin cover.

I. Field installation requirements.

1. A suction pipe shall be provided by the contractor and installed on each pump. The suction pipe must be of 1-piece construction, and shall be schedule-80 PVC, galvanized steel, or iron pipe. The size of the pipe shall be the same size as the pump suction connection. The suction pipes shall be installed air tight. The bottom end of the pipe shall be installed to a point measuring 6"-to-8” from the wet-well floor.
2. An appropriate sewage-type check-valve shall be provided by the contractor and shall be installed in the discharge line of each pump. An appropriate gate-valve or plug-valve shall be provided by the contractor and shall be installed downstream of the check-valve.

3. A small diameter air vent line & isolation-valve shall be provided by the contractor & installed on each pump, per the manufacturer's instructions. It shall be designed to evacuate any air on the discharge side of the pump-impeller, between the pump discharge nozzle and the discharge check valve. The outlet of the air vent line shall discharge into the wet-well through the basin-cover. The line shall extend from the basin-cover, down into the wet-well, and must terminate below the liquid-level, but no lower than a point 6"-to-8" above the bottom of the suction pipe. Galvanized tubing is not acceptable for this air vent line or suction pipe.
4.

J. Qualification Of Equipment Manufacturer:

1. In order to establish a standard of quality and to insure a uniform basis of bidding, the system shall be manufactured by Metropolitan Industries, Inc., or a prior written approval equal, approved by FMDC and FMO plumbing staff. To be considered an approved equal, complete details and shop drawings must be submitted to the engineer no later than ten (10) days prior to the bid date. Sufficient data must be submitted so that the engineer has the required information available to determine whether the alternate system meets the requirements of the specifications. The contractor shall prepare his bid on the basis of the specific system specified for purposed of determining the low bid. After the execution of the contract, substitution of non-specified equipment will be considered, if the substitution is, in the opinion of the engineer, equal in quality, substance, and performance to the named manufacturer. If such substitution is approved by the engineer, all savings affected by the contractor in the purchase of the substituted equipment shall be passed on to the owner by reducing the contract price. In submitting for substitution, the contractor shall provide certified copies of equipment proposals from the named manufacturer, as well as the substitute manufacturer.
2. The equipment manufacturer shall furnish 24 hour service for the complete system, and shall stock all integration parts used for the installation.

K. Start-Up Service:

1. The service of a factory-trained representative shall be made available on the jobsite for one (1) six-hour period of time, to verify proper installation of the system, provide start-up, and adjustment, and provide instructional operational training for the operator's personnel.

2.4 DOMESTIC COLD WATER PRESSURE BOOSTER PUMPING SYSTEM - HIGH PRESSURE (ABOVE 100 PSI)

A. Furnish and install a factory prefabricated multi-pump water pressure booster system with a separate hydro-pneumatic tank. System shall be of size and capacity as indicated on the Drawings. All wetted components of the system shall be constructed in strict compliance with ANSI/NSF-372, for low-lead content. System shall automatically provide complete pump shutdown during low-flow conditions while maintaining system pressure.

B. Pumps & Safety-Devices:

1. Pumps units shall be multi-stage centrifugal diffuser-type, of cast iron stainless-fitted construction, with one-piece replaceable stack-kits, and cartridge-type mechanical-seal.
2. The system shall have a separate pre-wired temperature probe and approved electrical purge valve, as well as an automatic pressure-relief valve, installed immediately downstream of each individual pump discharge nozzle.

3. Due to the potentially high outlet pressure of these safety-devices, each device shall each be piped to a common factory pre-fabricated 2" diameter drainage-header running the length of the structure, designed to dissipate the pressure energy prior to gravity drainage. Piping from the drainage-header to a waste opening shall be installed by the contractor in the field.

C. Motors:

1. Each pump shall be driven by a 3-Phase, 60 Hertz, open-drip-proof (ODP) motor. The motor shall have a synchronous speed of 3500 RPM, but shall operate at varying rates of speed during system operation. Each pump shall be driven by a NEMA Premium-Efficiency motor to keep pace with EISA protocols. Each pump must operate within the nameplate horsepower of the motor at all points along the entire pump capacity-head curve beyond the duty-point condition, reserving the available service factor of the motor as a safety-factor.
2. Pumps with performance curves which operate into the service (safety) factor, beyond the nameplate horsepower at any point, are not acceptable.

D. Hydro-Pneumatic Tank:

1. The following shall apply to all hydro-pneumatic tanks required by the pump-schedule. Furnish and install as shown on plans a pre-charged hydro-pneumatic tank or tanks. The tank shall be rated for a working pressure of 125-PSI minimum and a working temperature of 120°F minimum. All internal wetted parts must comply with FDA regulations and approvals. The tank shall be sized as scheduled.
2. The hydro-pneumatic tank shall include a replaceable flexible membrane, designed to separate the air and water. The flexible membrane shall contain the appropriate air-charge required to allow maximum water storage. A Schrader valve shall be located at the uppermost portion of the vessel, with a protective access cover. The tank shell shall be of composite material, comprised of filament-wound fiberglass, of sufficient wall thickness to contain water & air in combination, to a maximum working-pressure of 125-PSI. The unit shall have a stainless steel threaded or flanged elbow fitting, located at the lowermost portion of the tank, to allow maximum draw-down of the stored water. The fitting shall include a diffuser, designed to enhance water flow in & out of the vessel. The tank shall be manufactured entirely of corrosion-resistant materials. Fabricated steel vessels, which are susceptible to corrosion, are not acceptable.
3. The vessel shall be installed with isolation-valves in such a way as to allow the unit to be drained for maintenance purposes, without the need to drain the pressurized pump discharge line, or cause the operation of the pump system to be interrupted.
4. The pump control system shall include a 'sleep-mode' feature, which shall increase the set-point water pressure slightly during low-flow/no-flow situations, and increase the stored water pressure within the tank, in order to stop all pumps until increased flow-demand within the facility resumes.
5. The tank shall be installed at the appropriate elevation required in order to ensure that the maximum potential operating pressure does not exceed the rated maximum working pressure of the tank. The maximum potential operating pressure shall be considered to be the sum of the zero-flow shut-off head of the pump at full-speed, plus the maximum potential suction pressure at the system suction-header.

E. Power and Control System:

1. Furnish a single or multiple enclosure power and control system in NEMA-1 enclosures. The pumping system set-point pressure shall be accurately regulated by the control system. The control system shall include an individual variable frequency drive (VFD) for

each pump on the system, which shall adjust the kilowatt power delivered and used by the pump motors, as required to match the system flow demand requirement at any given time, while maintaining the set-point pressure of the system. The operating speed and kilowatt input to the pump motors shall be reduced to the minimum necessary to satisfy the flow demand, and to reduce mechanical wear of the equipment. The control system efficiency shall be maintained at 94 percent, and the system power factor shall be .95 at all times. The VFD shall always soft-start the pump motors in order to reduce momentary power demands, as well as to eliminate mechanical and hydraulic shock to the system and the facility.

2. The control system shall operate each pump independently and in-unison in order to maintain the system operating pressure set-point, as programmed by the operating engineer. Each of the pumps shall have its own VFD inverter.
3. A microprocessor based programmable logic controller (PLC) shall be furnished to process all of the operational input and output signals, including but not limited to, pressure set-points, operator selector settings, indicator lights and displays, and all alarm conditions. The logic program shall be factory installed and tested within the system and shall have provisions for field reprogramming through the use of a portable computer.

F. Pressure Transducers:

1. A system-pressure transducer shall be installed on the discharge-header of the pumping system.
2. A suction-pressure transducer shall be installed on the suction-header of the pumping system.
3. At the discretion of the University, compliance with the ruling of the U. S. Department of Energy imposing compliance with ANSI/ASHRAE Standard 90.1-2010 Addendum-CV may be required. In such cases, as indicated on the plan drawings, a third remotely-located pressure transducer shall be provided for installation at the furthermost point of the facility, designed to reduce the kilowatt requirement of the facility, by eliminating the calculated-friction-losses during low-to-medium flow periods. This transducer shall be the primary unit, and shall be utilized by the PLC to operate the system, in order to maintain the desired remote-pressure set-point.

    a. Fail-Safe Operation: The transducer mounted on the pump system discharge shall be the secondary transducer, and shall be a fail-safe unit, programmed to maintain system pressure, if the primary remote transducer should become inoperable.

G. System Operation:

1. System pressure and all other operating parameters shall be manually set by means of an operator interface screen on the face of the control system, as described herein. The proportional output signal from the pressure controller shall operate with internally set reset and rate response when following a pressure deviation that is within the adjusted proportional band. When pressure deviates from the set point in proportion greater than the internally adjusted proportional band, the controller shall control rapidly by bypassing rate in order to follow the rapidly changing pressure. The pressure controller shall maintain the variable speed proportional band for each pump.
2. The lead pump shall operate at varying rates of speed as required to maintain the desired system pressure. If a slight reduction of system pressure should occur when one pump is operating at the maximum programmed speed, a lag pump or multiple pumps, each as sequenced by system demand, shall accelerate and operate in-unison, to maintain stable system pressure during widely-varying flow-rate scenarios. After an adjustable period of time, the lag pump or pumps each as sequenced by demand, shall decelerate and turn

off. The lead pump designation shall alternate among all pumps on the system, every 23 hours.

3. Operator adjustment options shall be provided for multiple alarm conditions.

    a. Low suction pressure alarm indication and automatic shut-down. A low suction pressure condition will shut down the system until adequate suction pressure is restored.
    b. Low system pressure alarm indication. A low system pressure condition that is not satisfied by a pump within 30 seconds will signal an alarm.
    c. High system pressure alarm indication and automatic shut-down.

4. The system shall operate completely unattended, and shall have digital dry contact terminals for connection to the facility monitoring equipment.
5. At the discretion of the University, one (1) of the following monitoring systems may be required:

    a. Internet-Based Messaging-System: The control system shall be provided with a Metropolitan “Metro-Mail”, messaging system, designed to monitor and report the status of the equipment to key personnel, during regular and/or emergency situations. The unit shall be capable of sending e-mail messages or text messages through an internet connection. The equipment control system shall include singular or multiple remote alarm contacts as designated within the equipment control system specifications. These shall be factory pre-wired to the Metro-Mail messaging system, each powered by a 10-to-30 volt ac-or-dc power supply. The messaging system shall include eight (8) electrically-separated, optically-isolated digital inputs. Each pair of input terminals shall include a red led-indicator light, which shall illuminate when the circuit is energized. The messaging system shall also include a single led-indicator status-light. This light shall glow-green to indicate that the unit is powered and is properly configured; and shall flash to indicate that an e-mail is being transmitted. The led-indicator shall glow-amber to indicate that the unit is booting, or to indicate that an ip-number has not been assigned. An ethernet port shall be provided, to allow connection of the unit to an internet connection, using a standard or crossover ethernet cable. The Metro-Mail shall include an on-board web-server, allowing the user to configure messages; e-mail addresses; and other settings, via a standard web browser. The Metro-Mail shall be powered through the main equipment control system, via a 10-to-30 vac/dc power supply.
    b. BACNet Communications Module: The control system programmable logic controller (PLC) shall be provided with a BACNet compliant or serial interface, allowing 2-way communication with the building automation network, using BACNet protocol. The module shall support 2-channel data communication: One channel shall be configured for RS-485 half-duplex serial communications; and the other channel shall be configured for 10/100M Ethernet full-duplex. The data shall be stored on-board within the module.

H. The operator devices and indicators shall include:

1. A main power safety-disconnect for entire system.
2. A circuit breaker or fused safety-disconnect for each VFD.
3. A manual-off-automatic selection, for each pump.
4. A pump-running indication, for each pump.
5. A manual speed control - each pump.
6. A color touch-surface operator interface screen, to monitor and adjust all system parameters.

I. The color touch-surface operator interface panel shall incorporate the following design criteria & capabilities:

1. Incorporate a 5.6” Diagonal touch-surface, with a resolution of 320 x 234-Pixels, and Flash ROM of 4MB.
2. Capable of displaying a minimum of 65,500-colors.
3. Include an LCD display.
4. Include an LED backlight.
5. Incorporate one (1) USB Host version 1.1/1
6. Provide three (3) serial COM ports.
7. Include built-in perpetual calendar.
8. Have an operating voltage of 24Vdc.
9. Include a 3V lithium battery back-up power supply.

J. The operator interface panel shall provide trending screens, with multiple historical events:

1. Alarm event-logs, for all alarm conditions.
2. Discharge-pressure history.
3. Suction-pressure history.
4. VFD percent-speed – each VFD

K. Pump Sequencing

1. On-off sequencing shall be processed using the primary pressure signal, to enable ‘sleep-mode’ operation, and lead/lag pump operation. During typical daily operation, the pump sequencing at the programmed design conditions shall occur approximately as scheduled below:

(Select only one)

Duplex (2-Pump) System:

Pump #l shall operate only	0% - 60% of peak demand
Pump #1 and #2 shall both operate	61% - 120% of peak demand

Triplex (3-Pump) System:

Pump #l shall operate only	0% - 40% of peak demand
Pump #1 and #2 shall both operate	41% - 80% of peak demand
Pump #1, #2 and #3 shall all operate	81% - l20% of peak demand

Quadraplex (4-Pump) System:

Pump #l shall operate only	0% - 30% of peak demand
Pump #1 and #2 shall both operate	31% - 60% of peak demand
Pump #1, #2 and #3 shall all operate	61% - 90% of peak demand
Pump #1, #2 #3 and #4 shall all operate	91% - 120% of peak demand

Pentaplex (5-Pump) System:

Pump #l shall operate only	0% - 25% of peak demand
Pump #1 and #2 shall both operate	26% - 50% of peak demand
Pump #1, #2 and #3 shall all operate	51% - 75% of peak demand
Pump #1, #2 #3 and #4 shall all operate	76% - 100% of peak demand
Pump #1, #2 #3 #4 and #5 shall all operate	101% - 125% of peak demand

2. In order to eliminate short-cycling of the motors, the on-off pump sequencing shall be automatically restricted to a maximum of six cycles per hour, per pump, under the actual real-time load conditions.

L. Non-electronic Instrumentation:

1. The system shall include multiple individual pressure gauges; one for each pump, as well as one for indication of the total-system discharge pressure, and one for the system suction pressure. Stainless-steel or copper tubing, with isolation-valves, shall be installed between the connection-point and the gauge-location: The pressure-gauges shall be liquid-filled, and shall be mounted adjacent to one another on the control system front-panel. Each pressure gauge shall be clearly labeled with the appropriate connection-point.

M. Factory Prefabrication:

1. The entire water pressure booster system shall be factory prefabricated on a common structural steel frame & base assembly with all interconnecting piping and wiring completed and operationally tested prior to shipment. The only field connections required will be system suction and discharge headers, the drainage-header, and main power supply connection at the control panel. The remotely-located pressure transducer must by piped and wired by the contractors as well, when required by the contract.
2. The system shall include individual suction & discharge branch piping for each pump as well as common suction & discharge headers for the entire system. The piping & headers shall be fabricated of welded steel. The steel fabrications shall then be powder-coated with NSF-61 approved Scotchkote-134 fusion-bonded epoxy after all welding is complete, to ensure maximum corrosion-resistance.
3. A full-port threaded or flanged ball-valve or lug-type butterfly isolation valve shall be installed on the suction & discharge side of each pump, and each major component.
4. A threaded, flanged, or lug-type silent check valve shall be installed on the discharge side of each pump, between the pump & associated isolation valve. Projects within the city of Chicago shall also include a silent check valve on the suction side of each pump.
5. The piping, fittings, valves, and associated devices shall be pressure-rated as required to ensure that the maximum potential operating pressure of the system does not exceed the rated maximum working pressure of the components. The maximum potential operating pressure of the system shall be considered to be the sum of the zero-flow shut-off head of any pump at full-speed, plus the maximum potential suction pressure at the suction-header.
6. All piping, headers, valves, and associated devices shall be fully supported by the system's structural steel frame & base assembly. Support of the piping, headers, etc., by field-installed devices is not acceptable.
7. The diameter of the piping, valves, and headers shall be sized to minimize the full-flow velocity, as required to meet local code requirements, or engineer-approved acceptable velocity levels. When local code requirements are unclear, velocities may not exceed single-digit levels, as measured in feet-per-second, at full-flow.
8. When a remotely-located pressure transducer is required by the contract, it shall be plumbed in place along with a liquid-filled pressure-gauge, in the piping provided by the plumbing contractor, in the remote location indicated. The instrumentation contractor shall provide, route, and install the signal-cable from the transducer's remotely installed location, and shall terminate the cable in the water pressure booster system control panel.

N. Factory Test and Certification:

1. The fully-assembled system shall be factory flow-tested in the manufacturer's test-lab before shipment, to ensure correct operation. All of the specified functional & performance requirements are essential to project economics and are therefore subject to performance verification. Equipment that is found to be deficient with respect to these requirements shall not be accepted and shall be replaced at the contractor's expense with equipment that can meet these requirements. The flow-test shall be performed & certified in writing by a registered professional engineer (P. E.), at the expense of the manufacturer. The plumbing design engineer shall be provided the opportunity of a factory inspection and witness-testing of the system prior to shipment from the manufacturing plant, (not the distributor's facility), to ensure quality and specification-compliance. All costs associated with the inspection & witness-testing, including travel-expenses & lodging-expenses, shall be included in the manufacturer's price. Test shall include a system operating flow test from zero to 120% design flow rate under specified suction and net delivery pressure conditions.
2. Certification shall be provided to the plumbing design engineer for approval. Prior to shipment of the system from the factory. The certification must be approved in writing by the plumbing design engineer. The certification shall include copies of the test data as recorded by X-Y plotter, certified in writing by the registered professional engineer (P. E.) performing and witnessing the test.

O. Qualification Of Equipment Manufacturer:

1. In order to establish a standard of quality and to insure a uniform basis of bidding, the system shall be manufactured by Metropolitan Industries, Inc., or a prior written approval equal, approved by FMDC and FMO plumbing staff. To be considered an approved equal, complete details and shop drawings must be submitted to the engineer no later than ten (10) days prior to the bid date. Sufficient data must be submitted so that the engineer has the required information available to determine whether the alternate system meets the requirements of the specifications. The contractor shall prepare his bid on the basis of the specific system specified for purposed of determining the low bid. After the execution of the contract, substitution of non-specified equipment will be considered, if the substitution is, in the opinion of the engineer, equal in quality, substance, and performance to the named manufacturer. If such substitution is approved by the engineer, all savings affected by the contractor in the purchase of the substituted equipment shall be passed on to the owner by reducing the contract price. In submitting for substitution, the contractor shall provide certified copies of equipment proposals from the named manufacturer, as well as the substitute manufacturer.
2. The equipment manufacturer shall furnish 24 hour service for the complete system, and shall stock all integration parts used for the installation.

P. Start-Up Service:

1. The service of a factory-trained representative shall be made available on the jobsite for one (1) six-hour period of time, to verify proper installation of the system, provide start-up, fine-tuning, and adjustment, and provide instructional operational training for the operator's personnel.

2.5 DOMESTIC COLD WATER PRESSURE BOOSTER PUMPING SYSTEM - LOW PRESSURE (100 PSI MAXIMUM BUT ONLY 80 PSI MAXIMUM ALLOWED AT ANY PLUMBUING FIXTURE, COORDINATE WITH PLUMBING SYSTEM DESIGN)

A. Furnish and install a factory prefabricated multi-pump water pressure booster system with a separate hydro-pneumatic tank. System shall be of size and capacity as indicated on the Drawings. All wetted components of the system shall be constructed in strict compliance with

ANSI/NSF-372, for low-lead content. System shall automatically provide complete pump shutdown during low-flow conditions while maintaining system pressure.

B. Pumps & Safety-Devices:

1. Pumps shall be single stage end-suction design of cast iron stainless-fitted construction, equipped with mechanical shaft seal.
2. The system shall have a separate pre-wired temperature probe and approved electrical purge valve, as well as an automatic pressure-relief valve, installed immediately downstream of each individual pump discharge nozzle.
3. Due to the potentially high outlet pressure of these safety-devices, each device shall each be piped to a common factory pre-fabricated 2” diameter drainage-header running the length of the structure, designed to dissipate the pressure energy prior to gravity drainage. Piping from the drainage-header to a waste opening shall be installed by the contractor in the field.

C. Motors:

1. Each pump shall be driven by a 3-Phase, 60 Hertz, open-drip-proof (ODP) motor. The motor shall have a synchronous speed of 3500 RPM, but shall operate at varying rates of speed during system operation. Each pump shall be driven by a NEMA Premium-Efficiency motor to keep pace with EISA protocols. Each pump must operate within the nameplate horsepower of the motor at all points along the entire pump capacity-head curve beyond the duty-point condition, reserving the available service factor of the motor as a safety-factor.
2. Pumps with performance curves which operate into the service (safety) factor, beyond the nameplate horsepower at any point, are not acceptable.

D. Hydro-Pneumatic Tank:

1. The following shall apply to all hydro-pneumatic tanks required by the pump-schedule. Furnish and install as shown on plans a pre-charged hydro-pneumatic tank or tanks. The tank shall be rated for a working pressure of 125-PSI minimum and a working temperature of 120°F minimum. All internal wetted parts must comply with FDA regulations and approvals. The tank shall be sized as scheduled.
2. The hydro-pneumatic tank shall include a replaceable flexible membrane, designed to separate the air and water. The flexible membrane shall contain the appropriate air-charge required to allow maximum water storage. A Schrader valve shall be located at the uppermost portion of the vessel, with a protective access cover. The tank shell shall be of composite material, comprised of filament-wound fiberglass, of sufficient wall thickness to contain water & air in combination, to a maximum working-pressure of 125-PSI. The unit shall have a stainless steel threaded or flanged elbow fitting, located at the lowermost portion of the tank, to allow maximum draw-down of the stored water. The fitting shall include a diffuser, designed to enhance water flow in & out of the vessel. The tank shall be manufactured entirely of corrosion-resistant materials. Fabricated steel vessels, which are susceptible to corrosion, are not acceptable.
3. The vessel shall be installed with isolation-valves in such a way as to allow the unit to be drained for maintenance purposes, without the need to drain the pressurized pump discharge line, or cause the operation of the pump system to be interrupted.
4. The pump control system shall include a ‘sleep-mode’ feature, which shall increase the set-point water pressure slightly during low-flow/no-flow situations, and increase the stored water pressure within the tank, in order to stop all pumps until increased flow-demand within the facility resumes.

5. The tank shall be installed at the appropriate elevation required in order to ensure that the maximum potential operating pressure does not exceed the rated maximum working pressure of the tank. The maximum potential operating pressure shall be considered to be the sum of the zero-flow shut-off head of the pump at full-speed, plus the maximum potential suction pressure at the system suction-header.

E. Power and Control System:

1. Furnish a single or multiple enclosure power and control system in NEMA-1 enclosures. The pumping system set-point pressure shall be accurately regulated by the control system. The control system shall include an individual variable frequency drive (VFD) for each pump on the system, which shall adjust the kilowatt power delivered and used by the pump motors, as required to match the system flow demand requirement at any given time, while maintaining the set-point pressure of the system. The operating speed and kilowatt input to the pump motors shall be reduced to the minimum necessary to satisfy the flow demand, and to reduce mechanical wear of the equipment. The control system efficiency shall be maintained at 94 percent, and the system power factor shall be .95 at all times. The VFD shall always soft-start the pump motors in order to reduce momentary power demands, as well as to eliminate mechanical and hydraulic shock to the system and the facility.
2. The control system shall operate each pump independently and in-unison in order to maintain the system operating pressure set-point, as programmed by the operating engineer. Each of the pumps shall have its own VFD inverter.
3. A microprocessor based programmable logic controller (PLC) shall be furnished to process all of the operational input and output signals, including but not limited to, pressure set-points, operator selector settings, indicator lights and displays, and all alarm conditions. The logic program shall be factory installed and tested within the system and shall have provisions for field reprogramming through the use of a portable computer.

F. Pressure Transducers:

1. A system-pressure transducer shall be installed on the discharge-header of the pumping system.
2. A suction-pressure transducer shall be installed on the suction-header of the pumping system.
3. At the discretion of the University, compliance with the ruling of the U. S. Department of Energy imposing compliance with ANSI/ASHRAE Standard 90.1-2010 Addendum-CV may be required. In such cases, as indicated on the plan drawings, a third remotely-located pressure transducer shall be provided for installation at the furthermost point of the facility, designed to reduce the kilowatt requirement of the facility, by eliminating the calculated-friction-losses during low-to-medium flow periods. This transducer shall be the primary unit, and shall be utilized by the PLC to operate the system, in order to maintain the desired remote-pressure set-point.

   Fail-Safe Operation: The transducer mounted on the pump system discharge shall be the secondary transducer, and shall be a fail-safe unit, programmed to maintain system pressure, if the primary remote transducer should become inoperable.

G. System Operation:

1. System pressure and all other operating parameters shall be manually set by means of an operator interface screen on the face of the control system, as described herein. The proportional output signal from the pressure controller shall operate with internally set reset and rate response when following a pressure deviation that is within the adjusted

proportional band. When pressure deviates from the set point in proportion greater than the internally adjusted proportional band, the controller shall control rapidly by bypassing rate in order to follow the rapidly changing pressure. The pressure controller shall maintain the variable speed proportional band for each pump.

2. The lead pump shall operate at varying rates of speed as required to maintain the desired system pressure. If a slight reduction of system pressure should occur when one pump is operating at the maximum programmed speed, a lag pump or multiple pumps, each as sequenced by system demand, shall accelerate and operate in-unison, to maintain stable system pressure during widely-varying flow-rate scenarios. After an adjustable period of time, the lag pump or pumps each as sequenced by demand, shall decelerate and turn off. The lead pump designation shall alternate among all pumps on the system, every 23 hours.
3. Operator adjustment options shall be provided for multiple alarm conditions.

    a. Low suction pressure alarm indication and automatic shut-down. A low suction pressure condition will shut down the system until adequate suction pressure is restored.
    b. Low system pressure alarm indication. A low system pressure condition that is not satisfied by a pump within 30 seconds will signal an alarm.
    c. High system pressure alarm indication and automatic shut-down.

4. The system shall operate completely unattended, and shall have digital dry contact terminals for connection to the facility monitoring equipment.
5. At the discretion of the University, one (1) of the following monitoring systems may be required:

    a. Internet-Based Messaging-System: The control system shall be provided with a Metropolitan “Metro-Mail”, messaging system, designed to monitor and report the status of the equipment to key personnel, during regular and/or emergency situations. The unit shall be capable of sending e-mail messages or text messages through an internet connection. The equipment control system shall include singular or multiple remote alarm contacts as designated within the equipment control system specifications. These shall be factory pre-wired to the Metro-Mail messaging system, each powered by a 10-to-30 volt ac-or-dc power supply. The messaging system shall include eight (8) electrically-separated, optically-isolated digital inputs. Each pair of input terminals shall include a red led-indicator light, which shall illuminate when the circuit is energized. The messaging system shall also include a single led-indicator status-light. This light shall glow-green to indicate that the unit is powered and is properly configured; and shall flash to indicate that an e-mail is being transmitted. The led-indicator shall glow-amber to indicate that the unit is booting, or to indicate that an ip-number has not been assigned. An ethernet port shall be provided, to allow connection of the unit to an internet connection, using a standard or crossover ethernet cable. The Metro-Mail shall include an on-board web-server, allowing the user to configure messages; e-mail addresses; and other settings, via a standard web browser. The Metro-Mail shall be powered through the main equipment control system, via a 10-to-30 vac/dc power supply.
    b. BACNet Communications Module: The control system programmable logic controller (PLC) shall be provided with a BACNet compliant or serial interface, allowing 2-way communication with the building automation network, using BACNet protocol. The module shall support 2-channel data communication: One channel shall be configured for RS-485 half-duplex serial communications; and the other channel shall be configured for 10/100M Ethernet full-duplex. The data shall be stored on-board within the module.

H. The operator devices and indicators shall include:

1. A main power safety-disconnect for entire system.
2. A circuit breaker or fused safety-disconnect for each VFD.
3. A manual-off-automatic selection, for each pump.
4. A pump-running indication, for each pump.
5. A manual speed control - each pump.
6. A color touch-surface operator interface screen, to monitor and adjust all system parameters.

I. The color touch-surface operator interface panel shall incorporate the following design criteria & capabilities:

1. Incorporate a 5.6" Diagonal touch-surface, with a resolution of 320 x 234-Pixels, and Flash ROM of 4MB.
2. Capable of displaying a minimum of 65,500-colors.
3. Include an LCD display.
4. Include an LED backlight.
5. Incorporate one (1) USB Host version 1.1/1
6. Provide three (3) serial COM ports.
7. Include built-in perpetual calendar.
8. Have an operating voltage of 24Vdc.
9. Include a 3V lithium battery back-up power supply.

J. The operator interface panel shall provide trending screens, with multiple historical events:

1. Alarm event-logs, for all alarm conditions.
2. Discharge-pressure history.
3. Suction-pressure history.
4. VFD percent-speed – each VFD

K. Pump Sequencing

1. On-off sequencing shall be processed using the primary pressure signal, to enable 'sleep-mode' operation, and lead/lag pump operation. During typical daily operation, the pump sequencing at the programmed design conditions shall occur approximately as scheduled below:

(Select only one)

Duplex (2-Pump) System:

Pump #l shall operate only	0% - 60% of peak demand
Pump #1 and #2 shall both operate	61% - 120% of peak demand

Triplex (3-Pump) System:

Pump #l shall operate only	0% - 40% of peak demand
Pump #1 and #2 shall both operate	41% - 80% of peak demand
Pump #1, #2 and #3 shall all operate	81% - l20% of peak demand

Quadraplex (4-Pump) System:

Pump #l shall operate only	0% - 30% of peak demand
Pump #1 and #2 shall both operate	31% - 60% of peak demand
Pump #1, #2 and #3 shall all operate	61% - 90% of peak demand
Pump #1, #2 #3 and #4 shall all operate	91% - 120% of peak demand

Pentaplex (5-Pump) System:

Pump #l shall operate only	0% - 25% of peak demand
Pump #1 and #2 shall both operate	26% - 50% of peak demand
Pump #1, #2 and #3 shall all operate	51% - 75% of peak demand
Pump #1, #2 #3 and #4 shall all operate	76% - 100% of peak demand
Pump #1, #2 #3 #4 and #5 shall all operate	101% - 125% of peak demand

2. In order to eliminate short-cycling of the motors, the on-off pump sequencing shall be automatically restricted to a maximum of six cycles per hour, per pump, under the actual real-time load conditions.

L. Non-electronic Instrumentation:

1. The system shall include multiple individual pressure gauges; one for each pump, as well as one for indication of the total-system discharge pressure, and one for the system suction pressure. Stainless-steel or copper tubing, with isolation-valves, shall be installed between the connection-point and the gauge-location: The pressure-gauges shall be liquid-filled, and shall be mounted adjacent to one another on the control system front-panel. Each pressure gauge shall be clearly labeled with the appropriate connection-point.

M. Factory Prefabrication:

1. The entire water pressure booster system shall be factory prefabricated on a common structural steel frame & base assembly with all interconnecting piping and wiring completed and operationally tested prior to shipment. The only field connections required will be system suction and discharge headers, the drainage-header, and main power supply connection at the control panel.
2. The system shall include individual suction & discharge branch piping for each pump as well as common suction & discharge headers for the entire system. The piping & headers shall be fabricated of welded steel. The steel fabrications shall then be powder-coated with NSF-61 approved Scotchkote-134 fusion-bonded epoxy after all welding is complete, to ensure maximum corrosion-resistance.
3. A full-port threaded or flanged ball-valve or lug-type butterfly isolation valve shall be installed on the suction & discharge side of each pump, and each major component.
4. A threaded, flanged, or lug-type silent check valve shall be installed on the discharge side of each pump, between the pump & associated isolation valve. Projects within the city of Chicago shall also include a silent check valve on the suction side of each pump.
5. The piping, fittings, valves, and associated devices shall be pressure-rated as required to ensure that the maximum potential operating pressure of the system does not exceed the rated maximum working pressure of the components. The maximum potential operating pressure of the system shall be considered to be the sum of the zero-flow shut-off head of any pump at full-speed, plus the maximum potential suction pressure at the suction-header.
6. All piping, headers, valves, and associated devices shall be fully supported by the system's structural steel frame & base assembly. Support of the piping, headers, etc., by field-installed devices is not acceptable.
7. The diameter of the piping, valves, and headers shall be sized to minimize the full-flow velocity, as required to meet local code requirements, or engineer-approved acceptable velocity levels. When local code requirements are unclear, velocities may not exceed single-digit levels, as measured in feet-per-second, at full-flow.

8. When a remotely-located pressure transducer is required by the contract, it shall be plumbed in place along with a liquid-filled pressure-gauge, in the piping provided by the plumbing contractor, in the remote location indicated. The instrumentation contractor shall provide, route, and install the signal-cable from the transducer's remotely installed location, and shall terminate the cable in the water pressure booster system control panel.

N. Factory Test and Certification:

1. The fully-assembled system shall be factory flow-tested in the manufacturer's test-lab before shipment, to ensure correct operation. All of the specified functional & performance requirements are essential to project economics and are therefore subject to performance verification. Equipment that is found to be deficient with respect to these requirements shall not be accepted and shall be replaced at the contractor's expense with equipment that can meet these requirements. The flow-test shall be performed & certified in writing by a registered professional engineer (P. E.), at the expense of the manufacturer. The plumbing design engineer shall be provided the opportunity of a factory inspection and witness-testing of the system prior to shipment from the manufacturing plant, (not the distributor's facility), to ensure quality and specification-compliance. All costs associated with the inspection & witness-testing, including travel-expenses & lodging-expenses, shall be included in the manufacturer's price. Test shall include a system operating flow test from zero to 120% design flow rate under specified suction and net delivery pressure conditions.
2. Certification shall be provided to the plumbing design engineer for approval. Prior to shipment of the system from the factory. The certification must be approved in writing by the plumbing design engineer. The certification shall include copies of the test data as recorded by X-Y plotter, certified in writing by the registered professional engineer (P. E.) performing and witnessing the test.

O. Qualification Of Equipment Manufacturer:

1. In order to establish a standard of quality and to insure a uniform basis of bidding, the system shall be manufactured by Metropolitan Industries, Inc., or a written approval equal. To be considered an approved equal, complete details and shop drawings must be submitted to the engineer no later than ten (10) days prior to the bid date. Sufficient data must be submitted so that the engineer has the required information available to determine whether the alternate system meets the requirements of the specifications. The contractor shall prepare his bid on the basis of the specific system specified for purposed of determining the low bid. After the execution of the contract, substitution of non-specified equipment will be considered, if the substitution is, in the opinion of the engineer, equal in quality, substance, and performance to the named manufacturer. If such substitution is approved by the engineer, all savings affected by the contractor in the purchase of the substituted equipment shall be passed on to the owner by reducing the contract price. In submitting for substitution, the contractor shall provide certified copies of equipment proposals from the named manufacturer, as well as the substitute manufacturer.
2. The equipment manufacturer shall furnish 24 hour service for the complete system, and shall stock all integration parts used for the installation.

P. Start-Up Service:

1. The service of a factory-trained representative shall be made available on the jobsite for one (1) six-hour period of time, to verify proper installation of the system, provide start-up,

fine-tuning, and adjustment, and provide instructional operational training for the operator's personnel.

2.6 ELECTRIC WATER COOLERS

A. Water Coolers, **EWC**:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product by the following:

   a. Elkay Manufacturing Co. (Basis of Design, Model EZSTL8WS(VR)*K).
   b. Oasis
   c. Murdock

2. Description: Bi-level, lead-free, dual cabinet, vandal resistant, ADA accessible model for adults and children, ARI 1010, UL 399, NSF/ANSI 61 and 372, wall mounted water cooler with bottle filling station.

   a. Cabinets: Bi-level, with stainless steel basins and bottle filler wrapper (with ABS plastic alcove), and galvanized steel structure and stainless steel cabinetry.
   b. Bubblers: One, safety type, with adjustable stream regulators, located on each cabinet deck.
   c. Control: Push bar on front of each cabinet, and on sides.
   d. Bottle filling unit shall have touchless electronic activation with an auto 20 second shut-off timer, and an electronic display showing count of plastic bottles saved from waste.
   e. Supply: 3/8 inch with ball valve.
   f. Filter: One or more water filters complying with NSF 42 and NSF 53 for cyst and lead reduction to below EPA standards; with capacity sized for unit peak flow rate.
   g. Drain: Grid with 1-1/4 inch minimum horizontal waste and trap complying with ASME A112.18.2.
   h. Integrated silver ion anti-microbil protection shall be provided in key areas.
   i. Cooling System: Electric, with hermetically sealed compressor, R-134a refrigerant, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.

      1) Capacity: 8 GPH of 50 deg F cooled water from 80 deg F inlet water and 90 deg F ambient air temperature.
      2) Electrical Characteristics: 120-V ac; single phase; 60 Hz.

   j. Support: Type II, water cooler carrier.

2.7 SUMP PUMP SYSTEMS – DUPLEX – SUBMERSIBLE VORTEX OR SEMI-OPEN

A. Provide submersible sump pump systems, with digital process-controller, and two (2) digital level switches. The pumping system shall be designed for operation on single-phase power supplies, with pumps of the sizes and capacities as noted on the drawings. The pumps shall include either recessed vortex-type impellers, or semi-open impellers. The pumping systems shall be as manufactured by Metropolitan Industries, of Romeoville, IL.

B. An epoxy-coated steel basin cover shall be provided, and shall include sealed discharge pipe openings, inspection-opening and suspension devices for the level control level-switches.

C. Pump construction and design.

1. The pumps shall submersible type, with either fully-recessed vortex or semi-open impeller design.
2. The pumps shall be cast iron, stainless-fitted, designed with a stainless steel shaft, bearings, and a mechanical seal in an oil-filled chamber.
3. Each pump shall be driven by a single-phase motor, with built-in capacitors, as scheduled. The motor shall be oil-filled, for positive lubrication and heat-dissipation. Air-Filled motors, which must be fully-submerged at all times in order to dissipate heat, are not acceptable.

D. Process Control Unit.

1. Provide a single enclosure power and control enclosure (NEMA 1). The enclosure shall be a fiberglass composite material, and shall include a clear hinged-door, which shall allow maintenance personnel to monitor the process-controller without opening the door.
2. The enclosure shall include a main circuit-breaker, and a solid-state digital process-controller. The controller shall have the UL listing mark for industrial control panels. Relay-based control systems, which do not allow the flexibility of being re-programmed in the field when software upgrades are programmed, are not acceptable.
3. The pump & level switch power cords shall enter the enclosure through specialized grommets, designed to allow cord-plugs to be used, while providing a secure seal from the surrounding environment.
4. The process controller shall operate as follows:

a. The electronic level-control system shall operate through the use of two (2) solid-state strain-gauge type level-sensors.
b. The control system shall allow the user the ability to enter the menu-selections & wet-well level-setting adjustments through the use of digital touch-pad controls on the face of the controller, without the need to access the wet-well.
c. The process-controller shall be designed with the following fail-safe operational features and indicators:

1) The process-controller shall operate one pump during normal scenarios. The controller software shall be programmed to provide automatic alternating operation, in the event that a second pump is included or added to the system, by automatically alternating the pumps on each pumping cycle.
2) The unit shall continually monitor the functionality of the level-sensors and all pumps. The controller will enter a ‘state-of-alarm’ during pump-failure, sensor-failure, a high-level condition, or if excessive run-time is detected.
3) If one of the wet-well level-switches become inoperable, the fail-safe self-diagnostic process-controller shall be designed to continue uninterrupted automatic operation of one or both pumps, and all alarms & faults.

d. The process-controller shall include the following indicators:

1) One (1) power-on light.
2) One (1) LCD menu & selection display screen.
3) Two (2) touch-pad keys for up & down operator menu selection adjustments.
4) Two (2) pump-run lights.
5) One (1) alarm light.
6) Two (2) level-sensor status lights.

7) One (1) silence touch-pad to mute the audible alarm.
8) One (1) reset touch-pad to reset the system configuration.

e. The process-controller shall perform the following major functions:

1) Start and stop 1-pump during normal flow conditions.
2) Start and stop 2-pumps during extreme flow conditions, if two pumps are connected.
3) Alternate two pumps on successive cycles of operation.
4) Monitor & delay pump-starts to avoid short-cycling motors.
5) Monitor & delay pump-starts to avoid simultaneous starting of pumps following utility power losses.
6) Monitor & recognize inoperable level-switches, and modify system operation to compensate for this occurrence.
7) Provide easily identifiable alarm codes for the operating personnel to monitor.

f. The control system shall include the following devices, for use in remotely monitoring the system:

1) One (1) set: digital dry alarm contacts, to indicate state of alarm.
2) The control system shall be provided with a Metropolitan “Metro-Mail”, messaging system, designed to monitor and report the status of the equipment to key personnel, during regular and/or emergency situations. The unit shall be capable of sending e-mail messages or text messages through an internet connection. The equipment control system shall include singular or multiple remote alarm contacts as designated within the equipment control system specifications. These shall be factory pre-wired to the Metro-Mail messaging system, each powered by a 10-to-30 volt ac-or-dc power supply. The messaging system shall include eight (8) electrically-separated, optically-isolated digital inputs. Each pair of input terminals shall include a red led-indicator light, which shall illuminate when the circuit is energized. The messaging system shall also include a single led-indicator status-light. This light shall glow-green to indicate that the unit is powered and is properly configured; and shall flash to indicate that an e-mail is being transmitted. The led-indicator shall glow-amber to indicate that the unit is booting, or to indicate that an ip-number has not been assigned. An ethernet port shall be provided, to allow connection of the unit to an internet connection, using a standard or crossover ethernet cable. The Metro-Mail shall include an on-board web-server, allowing the user to configure messages; e-mail addresses; and other settings, via a standard web browser. The Metro-Mail shall be powered through the main equipment control system, via a 10-to-30 vac/dc power supply.

g. Control systems without all of the essential fail-safe operational features, lights, fault-codes, indicators, and remote-monitoring devices listed above are insufficient for the intended service, and are not acceptable.

E. Liquid level sensors.

1. Provide two (2) suspended solid-state digital level-switches, of the strain-gauge type, designed with no moving parts. Mechanically operated switches, which are more susceptible to failure, are not acceptable. Cord grips fastened to the basin-cover shall be used to support the level-switch cords. The switches shall be fastened to a stainless-steel

chain with anchor, in such a way that allows level-adjustment of the switches from above the basin cover. These level-switches shall be used to control & monitor liquid level in the wet-well.

F. Qualification Of Equipment Manufacturer:

1. In order to establish a standard of quality and to insure a uniform basis of bidding, the system shall be manufactured by Metropolitan Industries, Inc., or a written approval equal approved by FMDC and FMO. To be considered an approved equal, complete details and shop drawings must be submitted to the engineer no later than ten (10) days prior to the bid date. Sufficient data must be submitted so that the engineer has the required information available to determine whether the alternate system meets the requirements of the specifications. The contractor shall prepare his bid on the basis of the specific system specified for purposed of determining the low bid. After the execution of the contract, substitution of non-specified equipment will be considered, if the substitution is, in the opinion of the engineer, equal in quality, substance, and performance to the named manufacturer. If such substitution is approved by the engineer, all savings affected by the contractor in the purchase of the substituted equipment shall be passed on to the owner by reducing the contract price. In submitting for substitution, the contractor shall provide certified copies of equipment proposals from the named manufacturer, as well as the substitute manufacturer.
2. The equipment manufacturer shall furnish 24 hour service for the complete system, and shall stock all integration parts used for the installation.

G. Start-Up Service:

1. The service of a factory-trained representative shall be made available on the jobsite for one (1) six-hour period of time, to verify proper installation of the system, provide start-up, and adjustment, and provide instructional operational training for the operator's personnel.

2.8 SEWAGE EJECTOR PUMP SYSTEMS – DUPLEX – SUBMERSIBLE VORTEX

A. Provide submersible vortex sewage pump systems, with digital process-controller, and two (2) digital level switches. The pumping system shall be designed for operation on single-phase power supplies, with pumps of the sizes and capacities as noted on the drawings. The pumping systems shall be as manufactured by Metropolitan Industries, of Romeoville, IL.

B. An epoxy-coated steel basin cover shall be provided, and shall include sealed discharge pipe openings, inspection-opening and suspension devices for the level control level-switches.

C. Pump construction and design.

1. The pumps shall submersible recessed-impeller vortex type designed so that all solids pass through the volute, without passing through the impeller.
2. Pump designs which require solids to pass through the impeller on the way through the volute, which can tend to cause solids to become lodged between the impeller-blades and volute more easily, are not acceptable.
3. The pumps shall be cast iron, stainless-fitted, designed with a stainless steel shaft, bearings, and a mechanical seal in an oil-filled chamber.
4. Each pump shall be driven by a single-phase motor, with built-in capacitors, as scheduled. The motor shall be oil-filled, for positive lubrication and heat-dissipation. Air-

Filled motors, which must be fully-submerged at all times in order to dissipate heat, are not acceptable.

D. Process Control Unit.

1. Provide a single enclosure power and control enclosure (NEMA 1). The enclosure shall be a fiberglass composite material, and shall include a clear hinged-door, which shall allow maintenance personnel to monitor the process-controller without opening the door.
2. The enclosure shall include a main circuit-breaker, and a solid-state digital process-controller. The controller shall have the UL listing mark for industrial control panels. Relay-based control systems, which do not allow the flexibility of being re-programmed in the field when software upgrades are programmed, are not acceptable.
3. The pump & level switch power cords shall enter the enclosure through specialized grommets, designed to allow cord-plugs to be used, while providing a secure seal from the surrounding environment.
4. The process controller shall operate as follows:

    a. The electronic level-control system shall operate through the use of two (2) solid-state strain-gauge type level-sensors.
    b. The control system shall allow the user the ability to enter the menu-selections & wet-well level-setting adjustments through the use of digital touch-pad controls on the face of the controller, without the need to access the wet-well.
    c. The process-controller shall be designed with the following fail-safe operational features and indicators:

        1) The process-controller shall operate one pump during normal scenarios. The controller software shall be programmed to provide automatic alternating operation, in the event that a second pump is included or added to the system, by automatically alternating the pumps on each pumping cycle.
        2) The unit shall continually monitor the functionality of the level-sensors and all pumps. The controller will enter a ‘state-of-alarm’ during pump-failure, sensor-failure, a high-level condition, or if excessive run-time is detected.
        3) If one of the wet-well level-switches become inoperable, the fail-safe self-diagnostic process-controller shall be designed to continue uninterrupted automatic operation of one or both pumps, and all alarms & faults.

    d. The process-controller shall include the following indicators:

        1) One (1) power-on light.
        2) One (1) LCD menu & selection display screen.
        3) Two (2) touch-pad keys for up & down operator menu selection adjustments.
        4) Two (2) pump-run lights.
        5) One (1) alarm light.
        6) Two (2) level-sensor status lights.
        7) One (1) silence touch-pad to mute the audible alarm.
        8) One (1) reset touch-pad to reset the system configuration.

    e. The process-controller shall perform the following major functions:

        1) Start and stop 1-pump during normal flow conditions.
        2) Start and stop 2-pumps during extreme flow conditions, if two pumps are connected.

3) Alternate two pumps on successive cycles of operation.
4) Monitor & delay pump-starts to avoid short-cycling motors.
5) Monitor & delay pump-starts to avoid simultaneous starting of pumps following utility power losses.
6) Monitor & recognize inoperable level-switches, and modify system operation to compensate for this occurrence.
7) Provide easily identifiable alarm codes for the operating personnel to monitor.

f. The control system shall include the following devices, for use in remotely monitoring the system:

1) One (1) set: digital dry alarm contacts, to indicate state of alarm.
2) The control system shall be provided with a Metropolitan “Metro-Mail”, messaging system, designed to monitor and report the status of the equipment to key personnel, during regular and/or emergency situations. The unit shall be capable of sending e-mail messages or text messages through an internet connection. The equipment control system shall include singular or multiple remote alarm contacts as designated within the equipment control system specifications. These shall be factory pre-wired to the Metro-Mail messaging system, each powered by a 10-to-30 volt ac-or-dc power supply. The messaging system shall include eight (8) electrically-separated, optically-isolated digital inputs. Each pair of input terminals shall include a red led-indicator light, which shall illuminate when the circuit is energized. The messaging system shall also include a single led-indicator status-light. This light shall glow-green to indicate that the unit is powered and is properly configured; and shall flash to indicate that an e-mail is being transmitted. The led-indicator shall glow-amber to indicate that the unit is booting, or to indicate that an ip-number has not been assigned. An ethernet port shall be provided, to allow connection of the unit to an internet connection, using a standard or crossover ethernet cable. The Metro-Mail shall include an on-board web-server, allowing the user to configure messages; e-mail addresses; and other settings, via a standard web browser. The Metro-Mail shall be powered through the main equipment control system, via a 10-to-30 vac/dc power supply.

g. Control systems without all of the essential fail-safe operational features, lights, fault-codes, indicators, and remote-monitoring devices listed above are insufficient for the intended service, and are not acceptable.

E. Liquid level sensors.

1. Provide two (2) suspended solid-state digital level-switches, of the strain-gauge type, designed with no moving parts. Mechanically operated switches, which are more susceptible to failure, are not acceptable. Cord grips fastened to the basin-cover shall be used to support the level-switch cords. The switches shall be fastened to a stainless-steel chain with anchor, in such a way that allows level-adjustment of the switches from above the basin cover. These level-switches shall be used to control & monitor liquid level in the wet-well.

F. Qualification Of Equipment Manufacturer:

1. In order to establish a standard of quality and to insure a uniform basis of bidding, the system shall be manufactured by Metropolitan Industries, Inc., or a written approval equal

approved by FMDC and FMO. To be considered an approved equal, complete details and shop drawings must be submitted to the engineer no later than ten (10) days prior to the bid date. Sufficient data must be submitted so that the engineer has the required information available to determine whether the alternate system meets the requirements of the specifications. The contractor shall prepare his bid on the basis of the specific system specified for purposed of determining the low bid. After the execution of the contract, substitution of non-specified equipment will be considered, if the substitution is, in the opinion of the engineer, equal in quality, substance, and performance to the named manufacturer. If such substitution is approved by the engineer, all savings affected by the contractor in the purchase of the substituted equipment shall be passed on to the owner by reducing the contract price. In submitting for substitution, the contractor shall provide certified copies of equipment proposals from the named manufacturer, as well as the substitute manufacturer.

2. The equipment manufacturer shall furnish 24 hour service for the complete system, and shall stock all integration parts used for the installation.

G. Start-Up Service:

1. The service of a factory-trained representative shall be made available on the jobsite for one (1) six-hour period of time, to verify proper installation of the system, provide start-up, and adjustment, and provide instructional operational training for the operator's personnel.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Use carrier off-floor supports for wall-mounting equipment, unless otherwise indicated.

B. Use chrome-plated brass or copper tube, fittings, and valves in locations exposed to view.

3.2 INSTALLATION

A. Install all equipment per the manufacturer's instructions, and install floor mounted pump packages on 4" concrete housekeeping pads.

B. Install off-floor supports affixed to building substrate and attach wall-mounting equipment, unless otherwise indicated.

C. Install equipment level and plumb. For equipment indicated for children, install at height required by authorities having jurisdiction.

D. Install water-supply piping with shutoff valve on supply to each piece of equipment to be connected to water distribution piping. Use ball valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

E. Install trap and waste piping on drain outlet of each water cooler to be connected to sanitary drainage system.

F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 22 Section "Escutcheons for Plumbing Piping."

G. Delete paragraph below if sealants are provided in Division 07 Section "Joint Sealants."

H. Seal joints between water coolers and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to cooler color. Sealants are specified in Division 07 Section "Joint Sealants."

I. Install bypass valves around all domestic booster pumps. The domestic water should be able to flow freely and allow total isolation of the domestic booster pump package. Valves installed by the booster pump manufacturer are not considered part of the bypass valve system.

3.3 FIELD QUALITY CONTROL

A. Equipment Testing: After electrical circuitry has been energized, test equipment for compliance with requirements. Test and adjust controls and safeties.

1. Remove and replace malfunctioning units and retest as specified above.
2. Report test results in writing.

B. Properly disinfect equipment handling potable water.

C. Thoroughly flush all potable water systems. Coordinate flushing for FMO personnel to witness the flush. Obtain sign-off from FMO personnel and submit documentation for record.

3.4 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install in accordance with manufacturer’s instructions.

C. Comply with Section 22 0529 "Hangers and Supports for Plumbing Piping and Equipment"

3.5 CONNECTIONS

A. Comply with requirements for piping specified in Section 22 1118 "Domestic Water Distribution System" for water piping, and Section 22 1316 for sanitary drainage piping. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with Division 26 Sections for electrical connections and for wiring methods.

C. Connect controls as required.

D. Install piping adjacent to pumps/packages to allow service and maintenance.

E. Connect domestic water piping to booster pump package inlet and outlet. Install suction and discharge piping equal to or greater than size of package inlets and outlets.

1. Install shutoff valve and strainer on suction side of each pump, and check, shutoff, and throttling valves on discharge side of each pump. Install valves same size as connected

piping. Comply with requirements for valves specified in Section 22 0523 "General-Duty Valves for Plumbing Piping" and comply with requirements for strainers specified in Section 22 2114 "Plumbing Specialties."

2. Install pressure gage at suction of each pump and pressure gage at discharge of each pump. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Comply with requirements for pressure gages and snubbers specified in Section 22 0519 "Meters and Gages for Plumbing Piping."

3.6 ADJUSTING AND TESTING

A. Adjust pumps and other components to function smoothly and to deliver the specified flows, and lubricate motors and pumps as recommended by manufacturer.

B. Adjust initial pressure set points.

C. Set field-adjustable level and electrical switches and circuit-breaker trip ranges as indicated.

D. Adjust fixture flow regulators for proper flow and stream height.

E. Adjust water cooler temperature settings.

F. Perform complete testing on equipment per manufacturer's requirements and submit reports.

END OF SECTION 22 1000