SECTION 16906

PUMP CONTROL AND ANNUNCIATION SYSTEM

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PART 1 GENERAL

1.1 APPLICABLE PUBLICATIONS

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

AMERICAN NATIONAL STANDARDS (ANSI) PUBLICATIONS

C37.90-78 (R 1979)	Relays and Relay Systems Associated With Electric Power Apparatus
C62.41-80	Guide for Surge Voltages in Low Voltage AC Power Circuits

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS, INC. (IEEE) PUBLICATIONS

471-74 (R 1979)	Guide for Surge Withstand Capability (SWC) Tests

NATIONAL ELECTRICAL MANUFACTURER'S ASSOCIATION (NEMA) PUBLICATIONS

ICS 2-83 (R 3-86)	Standards for Industrial Control Devices, Controllers and Assemblies
ICS 4-83	Terminal Blocks for Industrial Control Equipment and Systems
250-87	Enclosures for Electrical Equipment (1,000 Volts Maximum)

MILITARY SPECIFICATIONS (MIL. SPEC.)

MIL-P-13949G & Supplment 1	General Specifications for Plastic Sheet, Laminated, Metal Clad (for Printed Wiring Boards)

MILITARY STANDARD (MIL-STD)

Fed Std 461C (Notice 1)	Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference

UNDERWRITERS' LABORATORY INC. (UL) PUBLICATION

1449-87	Transient Surge Suppression

1.2 GENERAL REQUIREMENTS

Section "Electrical General Requirements", applies to this section, with the additions and modifications specified herein.

1.3 SUBMITTALS

1.3.1 Certification of Manufacturer's Qualifications

1.3.2 Certified Shop Test Report

Include statement that the Pump Control Panel performs as specified.

1.3.2 Product Data

Submit product data for each product required by this section. Include manufacturer's published data or certified laboratory test data indicating that the product meets the specified requirements.

1.3.3 Shop Drawings

Submit shop drawings showing dimensions, weights, construction details for each enclosure. Drawings shall indicate size, location and mounting methods for each component of the control system. Shop drawings shall indicate, but not be limited to, the following:

a. Material, thicknesses, finishes.

b. Overall dimensions, front view, and sectional views.

c. System schematic, including flow diagrams, I/O list, and point-to-point wiring diagrams, set points, operating ranges, mounting locations, and indicators. Wiring diagrams shall have terminals identified.

d. General arrangement drawings showing location of equipment, interior and on door panels.

e. Bill of materials.

f. Installation instructions.

g. Written control sequence covering all inputs, outputs, and control scheme.

h. Wiring schematic and layout of each circuit board card in the microprocessor controller.

i. Generic, functional description of each control component.

1.3.4 Certified Test Report

Certified test report Including field acceptance report.

1.3.5 Plan for Field Acceptance Inspections and Tests

Includes check-out and certification forms for all devices and systems.

1.3.6 Government Approval

Government approval is required for the Pump Control Panel (PCP).

1.3.7 Operating and Maintenance Manuals

Include the PCP in the Operating and Maintenance Manual.

1.4 SHOP TESTS

The manufacturer shall shop test the PCP. The procedure shall include simulation of field components and shall provide for fully testing the pump control and annunciator system as a unit before delivery to the project site. The test shall, in a comprehensive manner, reveal system defects, including, but not limited to, functional deficiencies, operating program deficiencies, algorithm errors, timing problems, wiring errors, loose connections, short circuits, failed components and mis-application of components. The test shall be performed prior to shipment to the site and problems detected shall be corrected and the PCP re-tested prior to shipment to the job site. The testing and correction sequence shall be repeated until no problems are revealed and then two additional successful tests shall be performed. Submit certified test report within 15 days after completion of the test. The report shall include a statement that the Pump Control Panel performs as specified.

1.5 DESCRIPTION

1.5.1 Summary

This section specifies the requirements for Pump Control and Annunciation Systems.

1.5.2 Pump Control and Annunciation System, includes, but is not limited to, the following:

a. Pump Control Panel (PCP)

b. Microprocessor based controls

c. Graphic Display

d. Alarm Annunciator

* e. Operating and Product Recovery Tank Level Indicator Transmitters

* f. Issue Venturi Tube

* g. Return Venturi Tube

* h. Pressure Indicating Transmitters

* i. Differential Pressure Transmitters

* j. Fueling Pump Flow Switches

* k. Differential Pressure Switches

* l. Operating Tank Outlet Valve Limit Switches

* m. Control Valve Solenoid Operators

* n. Meter Transmitter

* o. Overfill Valve Limit Switches

[* p. Receiving Filter Separator Bypass Valve Limit Switch]

* See Mechanical Equipment Specifications

1.5.3 Interface Components

All power supplies, interface devices and all work required for a fully functional system conforming to design intent herein shall be provided. Each component shall be compatible with interconnected components, and shall perform the function for which it was designed. Installation and operation shall be in accordance with the manufacturer's recommended procedures and requirements.

1.5.4 Equipment Protection

Surge protection and lightning protection devices shall be provided. Overload devices shall be provided in power supplies, regulators, chargers and where otherwise required for protection of components from overload conditions. All overload devices shall be coordinated to minimize damage and downtime resulting from overloads and short circuits in the system. Automatic resetting circuit breakers will not be permitted.

1.6 WARRANTY

1.6.1 The Pump Control and Annunciator Panel

The pump control and annunciator panel including devices and software shall be warranted for a period of one year from the date of acceptance of the system by the Government. This warranty service shall include parts and labor service for equipment supplied under this specification; additionally, the manufacturer's service personnel shall isolate other operational problems to equipment supplied by others; however, any parts or repair required for equipment supplied by others will be the responsibility of the Government. Upon notification by the Government of system or component failure, the Contractor shall respond at the site with necessary parts within 5 working days.

PART 2 PRODUCTS

2.1 MANUFACTURER EXPERIENCE AND QUALIFICATION

Submit the following data for approval to the [_____ Division, Naval Facilities Engineering Command] [_____ District, Corps of Engineers]:

a. Certification stating that the manufacturer has manufactured and installed at least three microprocessor based systems for automatic cycling of pumps based upon varying dispensing demands ranging from 0 to 2400 (minimum) gallons per minute utilizing a minimum of four pumps in the system. At least one of the three microprocessor based systems shall be for dispensing jet fuel into aircraft fuel tanks.

b. Certification that the control systems have successfully operated over the last two years and are currently in service.

c. Project names, locations, and system description of these installations. Include user point-of-contact and current telephone numbers.

2.2 PUMP CONTROL PANEL (PCP)

NEMA ICS 2, NEMA ICS 4, NEMA 250 as applicable. Wiring methods and practices shall be in accordance with Joint Industrial Council recommendations as applicable, unless indicated or specified otherwise. Where two or more pieces of equipment performing, the same function are required, they shall be exact duplicates produced by the same manufacturer.

2.2.1 Enclosure

The PCP enclosure shall be a free-standing NEMA 250, Type 1, smooth, gasketed enclosure constructed of 12 gauge steel. All seams shall be continuously welded and there shall be no drilled holes or knockouts prior to delivery to the job site. Maximum panel dimensions shall be 90 inches high, 120 inches wide, and 30 inches deep. The panel may be factory assembled in sections, but shall be shipped fully assembled in one piece and shall have removable lifting eyes. Interior surfaces shall be properly cleaned, primed, and spray painted with white high-gloss enamel. Exterior surfaces shall have standard factory finish. Access shall be front only and shall consist of hinged doors each having 3-point latching mechanism. Doors shall open approximately 120 degrees. Rack mounting angles, swing-out panels and other component mounting hardware shall be installed such that servicing of one component shall not require removal or disconnection of other components. No clearance shall be required between the back of the panel and the room wall. Terminal facilities shall be arranged for entrance of external conductors from the top of the enclosure.

2.2.2 PCP Components

2.2.2.1 The following components shall be mounted within the PCP:

a. Microprocessor controllers

b. Printed circuit boards as required

c. Input/Output Modules

d. Power conditioners

e. Power supplies for transmitters

f. Space heaters

g. Terminal blocks

h. Surge suppression devices

i. Battery chargers

j. Batteries

k. Arithmetic devices for signal scaling and square root extraction

l. Ventilation Fan(s) and replaceable filters

2.2.2.2 The following components shall be mounted on or through door panels or end walls as indicated.

a. Graphic Display

b. Operator Controls
c. Alarm Annunciator

d. Pressure/Flow Recorder

e. Digital Indicators

2.2.3 The PCP shall include all required resident software programs to provide the specified sequence of operation. Control shall be performed in a digital manner by the microprocessors and converted to electric signals operating motor starters, solenoids, alarms, and indicating lights. Controllers and I/0 modules shall function properly at temperatures between 32 and 122 degrees F, zero and 95 percent relative humidity (noncondensing), and input voltage between plus 10 and minus 15 percent at 60 Hertz, and stored at temperatures between minus 4 and plus 140 degrees F and zero and 95 percent relative humidity (noncondensing).

2.2.4 Transient surge suppression devices shall be installed in the PCP as recommended by equipment manufacturers to minimize the effects of nearby lightning strikes, switching on and off motors and other inductive loads. Transient protection shall meet the requirements of ANSI C62.41 for Category "B" transients, shall comply with UL 1449, and shall be UL listed.

2.2.5 Terminal Blocks:

NEMA ICS 4. Terminal blocks for conductors exiting the PCP shall be two-way type with double terminals, one for internal wiring connections and the other for external wiring connections. Terminal blocks shall be made of bakelite or other suitable insulating material with full deep barriers between each pair of terminals. A terminal identification strip shall form part of the terminal block and each terminal shall be identified by a number in accordance with the numbering scheme on the approved wiring diagrams.

2.2.6 Forced air ventilation shall be provided to maintain interior air temperature no greater than 10 degrees F above ambient. Provide redundant ventilating units powered from separate panelboard branch circuits. Ventilating units shall have replaceable air filters.

2.2.7 Comply with MIL-STD-461 relative to radiated and conducted radio interference.

2.3 MICROPROCESSOR BASED CONTROLLERS:

2.3.1 Two microprocessor based controllers shall be provided within the PCP. Power shall be supplied to each microprocessor through separate identical power conditioners and battery systems. The two microprocessor based controllers shall operate in a redundant fashion. At any given time, only one processor shall actively control the process. Critical operating data shall be constantly transferred from the active processor to the backup processor. Means shall be provided

to keep the backup processor, automatically updated by the active processor, ready to assume control if the active processor fails. If the active processor fails, the backup processor shall automatically assume control with no interruption to the process. The redundancy hardware shall have provisions to manually transfer control, by use of a lock-out key, from one processor to the other with no interruption to the process. Access to program and program modifications shall be protected by key switch or software code.

Where these specifications employ the words "the microprocessor", "the power conditioner" or similar singular expressions, the intent is that both systems shall conform.

2.3.2 Controllers shall be of modular construction to facilitate easy replacement of functional components.

2.3.3 The operating program shall be stored in battery-backed memory and fully capable of cold start without operator intervention. Cold start values of operator adjustable parameters shall be permanently stored and shall be set at the value specified herein. The operator, through the use of thumbwheel switches and a key-operated execute button, shall have the ability to change system operating parameters within programmed limits as follows without the use of tools or supplementary equipment.

Addressable Parameter	Programmable Range	Cold Start/Default Value
*[Lead pump starting pressure]	[30 to 150 psi	60 psi]
Issue flow to start second pump in sequence	450 to 650 gpm	560 gpm
Return flow to enable next pump in sequence to start	10 to 100 gpm	40 gpm
Return flow to stop second pump in sequence (lag pump)	500 to 800 gpm	700 gpm
Return flow to initiate lead pump shutdown sequence	500 to 800 gpm	560 gpm
**[Timer to stop lead pump]	[0 to 15 minutes	10 minutes]
*[Timer to enable start-up of lead pump]	[0 to 120 seconds	0 seconds]
Timer to enable second pump to start	0 to 120 seconds	10 seconds
Timer to stop second (lag pump) pump	0 to 120 seconds	15 seconds
*[Timer to disable Back Pressure Control Valve]	[0 to 120 seconds	60 seconds]
Timer to establish fueling pump failure	5 to 20 seconds	10 seconds
*[System pressure to stop	[[ ] to [ ] psig	175 psig]

lead pump]

Operating Tank No. 1 low level indication	0.0 to [5.0] feet (to tenths of a foot)	[ ]
Operating Tank No. 2 low level indication	0.0 to [5.0] feet (to tenths of a foot)	[ ]
Operating Tank No. 1 high level indication	[ ] to [ ] feet (to tenths of a foot)	[ ]
Operating Tank No. 2 high level indication	[ ] to [ ] feet (to tenths of a foot)	[ ]
Operating Tank No. 1 high-high level indication	[ ] to [ ] feet (to tenths of a foot)	[ ]
Operating Tank No. 2 high-high indication	[ ] to [ ] feet (to tenths of a foot)	[ ]

NOTE: THE PROGRAMMABLE RANGE AND COLD START VALUES FOR OPERATING TANK LEVEL INDICATION SHOULD BE COORDINATED WITH OPERATING TANK SIZE/CAPACITY SELECTED. DELETE THE ADDRESSABLE PARAMETER ACCOMPANIED BY AN ASTERISK (*) FOR CONTROL SCHEME "A". ADDRESSABLE PARAMETER ACCOMPANIED BY TWO ASTERISKS (**) APPLY TO SCHEME "A" ONLY.

Should the operator enter a value not within the range for that parameter, the 20 character display shall indicate "INVALID ENTRY". Addressable parameters shall be stored in volatile memory with battery back-up.

2.3.4 Each microprocessor controller shall constantly perform self diagnostic routines to identify faults in the processors and serial interfaces and shall alert the operator of any fault. The processor shall identify two types of diagnostic faults, critical faults and non-critical faults. Critical faults shall alert the operator, shut down the faulty controller, and initiate an automatic switchover sequence to the other controller. Non-critical faults shall alert the operator, shut down only the hardware affected and continue operation by utilizing healthy system components. The system shall provide a means during the configuration stage to convert any critical faults to "fault". A "fatal" fault shall behave like a critical fault.

The diagnostic routines shall be regularly performed during normal system operation. A portion of the scan time of the controller should be dedicated to perform these housekeeping functions. In addition, a more extensive diagnostic routine should be performed at power up and during normal system shutdown.

Each microprocessor circuit board shall have on board LEDs for a visual indication of the health of the circuit board.

2.4 INPUT/OUTPUT (I/O) MODULES AND TERMINAL STRIPS

Provide optically isolated I/O components which are compatible with field devices. I/O equipment shall be rack mounted and shall be protected against surge in accordance with IEEE 472.

2.5 POWER CONDITIONERS

Provide a power conditioner for each microprocessor. Power conditioner output capacity shall be sufficient to drive all equipment connected thereto plus 50% spare capacity.

2.5.1 Power Conditioner Electrical characteristics shall meet or exceed the following:

2.5.1.1 Input voltage shall be 120 volts (nominal), 1 phase, 60 Hertz.

2.5.1.2 Output voltage regulation shall be $\pm$ 0.5% for the following conditions:

a. 20% to 100% load on output.

b. Input voltage variation -15% to +10%.

c. Constant load power factor between 80% and 100%.

2.6 BATTERY CHARGERS

Provide battery charger for each power conditioner battery back-up system. Battery charger shall be solid state, fully automatic, with constant voltage, or constant current changing characteristics as recommended by the battery manufacturer. Provide automatic float and charge of batteries. Provide for full battery recharging within 18 hours.

2.7 BATTERY BACKUP

The processor configuration shall reside in battery backed RAM memory. The battery shall be a sealed, maintenance-free battery with 10 year minimum operating life. The battery shall be able to maintain the integrity of the program memory for at least 30 days after total loss of the incoming 60 Hz power. A battery OK status LED shall be provided in the front of the processor for visual indication of the condition of the battery. The battery status LED shall indicate a problem at least 3 days before the battery becomes weak enough to jeopardize the integrity of the memory. The battery system shall provide the means to manually insert a new battery to replace the weak one without jeopardizing the memory integrity even when the incoming 60 Hz power is not available.

2.8 SPACE HEATERS

Provide thermostatically controlled space heaters of sufficient wattage to maintain temperature of PCP components within operating limits as determined by manufacturer of each PCP component.

2.9 GRAPHIC DISPLAY

2.9.1 The Graphic Display shall depict the process fuel flow schematically as indicated on the drawings. Red, green, amber and white LEDS or miniature raised lens indicator lights shall be integrated with the process schematic to provide current equipment status graphically. Lights shall be located immediately adjacent to related equipment symbol.

2.9.2 The process schematic graphic representation shall utilize conventional symbols when possible. Symbols and flow lines shall be sized and spaced so as to provide a clear representation of the system

process. The graphic shall be adhered to a permanent aluminum substrate. All background colors, component colors, lettering and detail colors shall be laminate sealed with a clear epoxy coating which is chemical resistant yet provides the clarity of a polyester finish. Provide textured non-glare finish. The Graphic Display shall be suitable for supervised field modification when future items are added.

2.9.3 Provide a push-to-test button to test all lamps simultaneously. Provide a standard carton (minimum 10) spare lamps.

2.9.4 The Graphic Display shall be as shown on the drawings. Minor changes may be incorporated to allow proper line width and spacing. Component arrangement, piping routing, and location of valves shall match the flow diagram except as noted on the drawing.

2.9.5 Digital Level Indicators

Digital level indicators shall be provided to indicate level of contents in each operating tank and in the product recovery tank. Digital level indicators shall accept an input from the microprocessor and shall display the specified range on a digital display with approximately 0.8-inch high, 7-segment LED or vacuum fluorescent characters. For the operating tanks, the range shall be 0 to [__] feet and for the product recovery tank, the range shall be 0 to [__] feet.

2.9.6 Electronic Counter

An electronic counter shall be provided to indicate a totalized count in gallons of fuel which passes through the positive displacement fuel meter at the pumphouse. Counting rate shall correspond to the readout at the meter. The counter shall have integral front panel reset. The display shall match those of the digital level indicators, except for number of displayed digits. The counter input shall be compatible with the output of the associated transmitter at the positive displacement meter.

2.10 PCP OPERATOR CONTROLS

The PCP Operator Control Panel shall include the following:

a. 20 Character Alphanumeric Display

b. Mode Selector Switch - "REFUELING-OFF-LOOP FLUSH-PANTOGRAPH FLUSH"

c. System "RESET" Pushbutton

d. "ADDRESS" Thumbwheel Switch

e. "DATA" Thumbwheel Switch

f. "DISPLAY" Pushbutton

g. "EXECUTE" Pushbutton with keyed operator

h. Pressure/Flow Recorder (3-pen)

i. "EMERGENCY" STOP" Pushbutton

j. "POWER ON" Indicator Light

k. Lead Pump Selector Switch, [2-position] [3-position]

l. Graphic Display "Lamp Test" Pushbutton

2.11 ALARM ANNUNCIATOR

The alarm Annunciator shall provide visual annunciation, local and remote monitoring, constant or flashing visual and audible alarm as specified herein.

2.12 The annunciator shall be completely solid state with no moving parts. The annunciator shall be furnished with cabinet and hardware appropriate for flush mounting on the side of the control panel. An integral power supply shall operate on 120 volts, 60 Hertz. Logic shall be tested for surge withstand capability in accordance with IEEE Std. 472 and ANSI C37.90. Logic circuits shall be on printed circuit boards which meet MIL-P-13949. The annunciator shall have windows arranged in a matrix configuration (rows and columns). The minimum number of windows shall correspond to the number of alarm points, plus 15% spare. Each window shall be at least 15/16" high by 1-5/8" wide and shall have rear illuminated translucent engraved nameplate. Lettering shall be both engraved and painted on the surface of each window; except that spare windows shall not have lettering. Lettering shall be at least 5/32 inches high. System logic and lamp voltage shall be 24 to 28 volts dc.

PART 3 EXECUTION

3.1 PCP COMPONENTS

It is intended that process controlling devices except motor controllers be attached to or mounted within the PCP enclosure and all interconnecting wiring installed prior to shipment to the jobsite. This is to allow shop testing of the system and to decrease field labor requirements.

3.1.1 Microprocessor-Based Controllers

Each microprocessor shall be separately rack mounted within the PCP enclosure and shall be easily removable. Disturbance of individual terminations shall not be required for removal or insertion. Microprocessors shall be identical to allow interchanging of parts.

3.1.2 Matching Style, Appearance, and Type

All display instruments of each type shall represent the same outward appearance, having the same physical size and shape, and the same size and style of numbers, characters, pointers, and lamp lenses.

3.1.3 I/O Modules and Terminal Strips
Interconnecting wiring between microprocessors and I/O equipment, and between I/O equipment and field wiring terminal strips shall be completely installed prior to shipment to the job site. I/O components shall be rack mounted within the PCP enclosure and shall be easily removable for servicing or replacement.

3.1.4 Power Conditioners

Interconnecting wiring between power conditioners and microprocessors, batteries, chargers shall be completely installed prior to shipment to the jobsite.

3.1.5 Battery Chargers

Battery chargers shall be rack mounted within the PCP enclosure.

3.1.6 Batteries

Follow manufacturer's recommended procedures for mounting, shipping and activation of batteries.

3.1.7 Space Heaters

Mount space heaters within PCP enclosure. Provide adequate separation from PCP components to prevent overheating of components. Provide adequate guards for personnel protection.

3.1.8 Graphic Display

The Graphic Display shall be surface mounted on the front surface of PCP door(s). Conductor routing shall allow door(s) to be fully opened. Access to Graphic Display components shall be from the rear of the door panel. The Graphic Display shall be supported and trimmed by a brushed aluminum frame enclosing all sides. Suitable gasketing and sealing shall provide for cushioning and expansion of the panel surface.

3.1.9 Operator Controls

Operator control devices shall be flush mounted through PCP enclosure door panel(s) and shall be arranged to allow easy vision and operation of each control device.

3.1.9.1 20 character alphanumeric display with red dot matrix characters or red character segments shall be used for display of all system parameters one at a time.

3.1.9.2 "REFUELING-OFF-LOOP FLUSH-PANTOGRAH FLUSH" mode selector switch: A 4-position selector switch shall allow the operator to select the "REFUELING" mode of operation or the "LOOP FLUSH" mode of operation, or the "PANTOGRAPH FLUSH" mode of operation, or "OFF".

3.1.9.3 "Lead Pump" Selector Switch: A [2-position] [3-position] selector switch shall allow the operator to select the lead pump. Selection of the lead pump shall fix the starting sequence for all pumps thus: [1-2, 2-1] [1-2, 2-3, 3-1].

3.1.9.4 Address Thumbwheel Switch - Used to select a program address for display or entering of new data. New data shall be entered simultaneously into both microprocessor #1 and microprocessor #2 registers.

3.1.9.5 Data Thumbwheel Switch - Used to enter numeric data.

3.1.9.6 Display Pushbutton - Used to display data at a previously set address. If contents of equivalent registers in the two microprocessors are not the same, the display shall display an appropriate error message.

3.1.9.7 Execute Pushbutton - Used to enter new data at a previously set address. Pushbutton shall require key activation.

3.1.9.8 Pressure/Flow Recorder - A three channel continuous plotting strip chart recorder shall record system pressure, issue flow and return flow. One pen shall record 0 to 1200 GPM on a linear chart for the Issue Venturi flow rate. One pen shall record 0 to 800 GPM on a linear Chart for the Return Venturi flow rate. The third pen shall record main pipeline pressures from 0 to 275 psi on a linear chart. Each of the three channels shall be equipped with a calibrated scale segment to reflect the current engineering value of the process measurement assigned to that channel or a digital display shall indicate each of the three channels in engineering units. Zero for each scale shall appear at the bottom or left side of the scale segment. Multipliers applied to these scales shall be 1 or a power of 10. The entire unit shall be totally enclosed in a case suitable for flush or semi-flush mounting. A two speed drive motor shall provide chart speeds of 1 inch per hour and 8 inches per hour. Pens shall be disposable markers of three different highly visible colors. Each marker shall allow for 3000 feet of line length, minimum. The strip chart recorder shall meet or exceed the following:

Accuracy	0.5% of calibrated span
Repeatability	0.25% of calibrated span
Input/Pen Motion	linear
Speed of Response	less than 2 seconds for full scale travel
Pen Drive	Servo motor with overrange protection
Plotting Chart	4" nominal width strip chart, minimum 50 feet long

Provide an integral on-off switch for the recorder.

3.1.9.9 Emergency Shutdown - Provide a momentary contact pushbutton with red mushroom operator. Depression of this button shall stop all pumps, de-energize all solenoid outputs and provide 10 amp, 120 volt DC rated contact closure for alarm purposes. Although pump shutdown will be done independent of the microprocessors; automatic pump shutdown by the PCP is also required for an additional margin of safety.

3.2 ALARM ANNUNCIATOR

3.2.1 The Alarm Annunciator Panel shall be surface mounted on the end wall of the PCP.

3.2.2 Provide a push-to-test button for lamps. Provide a standard carton (minimum 10) spare lamps.

3.2.3 Signals shall be initiated by hardwired field contact or by PCP outputs as required. The annunciator shall energize a horn and flash the appropriate annunciator lamp. Alarm sequence shall be as follows:

a. For a normal condition, visual indicator and horn will be of;

b. For an alert (alarm) condition, visual indicator will flash and horn will sound (this condition will be locked in);

c. Upon acknowledgement of the alert condition, visual indicator will be steady on and the horn will be off;

d. If, after acknowledgment of an alert condition, another alert condition is established, the new alert will cause the appropriate window to flash and the horn to sound;

e. When condition returns to normal after acknowledgment, the visual indicator and the horn will be off.

3.2.4 The following local and/or remote conditions shall be annunciated and sound a vibrating horn:

Pump #1 Failure

Pump #2 Failure

[Pump #3 Failure]

High Level Oil/Water Separator

System 1 Fault*

System 2 Fault*

High Pressure Drop Receiving Filter Separator

High Level Product Recovery Tank

Product Recovery Tank Overfill Valve Closed

Product Recovery Tank Leak

Engine-Generator Fault

* System fault alarm shall be initiated upon detection of system fault.

3.2.5 The following remote conditions shall be annunciated and sound a resonating horn.

Emergency Stop

Low Level Operating Tank #1 (if associated outlet valve is not fully closed)
Low Level Operating Tank #2 (if associated outlet valve is no t fully closed)

High-High Level Operating Tank #1

High-High Level Operating Tank #2

3.3 PCP FUNCTIONS

3.3.1 Two microprocessors, each capable of controlling the system, shall be provided. Each microprocessor shall have its own power supply and shall be completely independent of the other. The control sequence

requirements are presented under PART 4 - SYSTEM CONTROL SEQUENCE in this specification.

3.4 INSTALLATION

Installation shall conform to the manufacturer's drawings, written recommendations and directions.

3.4.1 Field Service

The Contractor shall provide technical manufacturer field personnel for the purpose of placing the pump control and annunciation system in operation and making necessary adjustments to insure optimum operation. Upon completion of the work and at a time designated by the Contracting Officer, furnish the services of a competent technician regularly employed by the PCP manufacturer for the instruction of Government personnel in the operation and maintenance of the system. Provide both classroom type theory instruction and hands-on instruction using operating equipment provided. The period of instruction shall be for not less than two 8-hour working days.

3.4.2 Plan for Instructing Operating Personnel

Furnish a written lesson plan and training schedule for Government approval at least 60 days prior to instructing operating personnel. This plan shall be tailored to suit the requirements of the Government. Materials supplied shall include the "Operation and Maintenance Manuals" required and as-built control drawings. Provide a detailed description of the system, including method for change over to stand-by generator power upon loss of main power source, and manual operation of pumps without power to the PCP. Provide a complete listing of software programs required to perform the sequence of operation. Describe all commands, operating and trouble shooting instructions, and routine maintenance procedures to be used with the systems. Provide eight complete approved instruction manuals which will be used for instructing operating personnel.

3.4.3 Field Inspection and Tests

Testing shall be coordinated with the overall fueling system test specified in section entitled "SYSTEM START-UP, FUELING". Prior to this test, all field connections shall have been made interconnecting the PCP, the motor control center, pilot devices, solenoids, actuators, and transmitters. In addition, wiring shall have been checked for continuity and short circuits. Perform tests in such a way as to obtain information about the performance of the PCP, transmitters, pilot devices, relays, meters, indicators, graphics panel lights, and alarms. Tests shall be performed or supervised by competent employees of the system supplier. If the Contracting Officer witnesses tests, such tests shall be subject to approval. If the Contracting Officer does not witness tests, provide performance certification. Field inspection and tests shall be performed as stated in approved inspections and test plan.

3.4.4 Test for Radio Frequency Interference (RFI)

Conduct test in accordance with MIL-STD-461. All testing equipment, instruments, personnel for making the tests, the test location which shall be reasonably free from radiated and conducted interference, and

other necessary facilities shall be furnished by the Contractor. Tests for RFI will not be required for items that are physically and electrically identical to those that have previously met the requirements of the above specifications.

3.4.5 Plan for Inspections and Tests

Furnish a written inspections and test plan at least 60 days prior to the field acceptance test date. This plan shall be developed by the system supplier. The plan shall delineate the inspections and testing procedures required for components and systems to demonstrate compliance with the requirements specified in the paragraph titled "Field Acceptance Testing." Additionally, the test plan shall indicate how the system is to be tested, what variables will be monitored during test, names of individuals performing tests, and what criteria for acceptance should be used. Indicate how operation of system will be simulated.

3.4.6 Field Acceptance Testing

Upon completion of 72 hours of continuous systems operation and before final acceptance of work, test the control systems in service to demonstrate compliance with contract requirements. Notify the Contracting Officer a minimum of ten working days prior to the date testing is to commence. Test controls and systems through each cycle of operation. Test safety controls to demonstrate performance of required functions. Adjust or repair defective or malfunctioning equipment or replace with new equipment. Repeat tests to demonstrate compliance with contract requirements.

3.5 TOOLS AND SPARE PARTS

Any special tools necessary for maintenance of the equipment shall be furnished as well as one spare set of fuses of each type and size required. One spare printed circuit board card shall be provided for each type of card in the microprocessor controller. In addition, the Contractor shall furnish a list of items recommended by the manufacturer to assure efficient operation for a period of 120 days at the installation. Include part number, current unit price, and source of supply.

PART 4 SYSTEM CONTROL SEQUENCES

NOTE: An asterisk (*) adjacent to a number in the system control sequence indicated that the number may be changed by the operator with the use of furnished key.

4.1 SCHEME "A" REFUELING SEQUENCE OF OPERATION

4.1.1 With the mode selector switch in the "REFUELING" position and pump starter switches in the "AUTO" position, refueling may be initiated at each of the aircraft direct fueling stations. An operator connects a pantograph to an aircraft and depresses the "START" pushbutton at the fueling station. This starts the selected lead fueling pump establishing a flow of 600* $\pm$ gpm through the system issue venturi and energizes the back pressure control valve (BPCV) solenoid allowing BPCV to modulate at its setpoint. To refuel and operator depresses the hydraulic (line pressure) "deadman" control. This opens the refueling control valve establishing flow to the aircraft.

4.1.2 With DPT-1 (or DPT-2) sensing differential pressure corresponding to a flow rate of 600* ± gpm through the issue venturi and DPT-3L or (DPT-4L) sensing differential pressure corresponding to a flow rate of less than 40* ± gpm through the return venturi for a period of 10 seconds, the second pump will be started automatically. If flow rate through the return venturi does not remain less than 40 ± for the 10* second interval, the timer will reset, and the second pump will not start.

4.1.3 With DPT-1 or (DPT-2) sensing differential pressure corresponding to a flow rate of 1200 ± gpm through the issue venturi and DPT-3L (or DPT-3H) and DPT-4L (Or DPT-4H) sensing differential pressure corresponding to a flow rate greater than 40* ± gpm but less than 700* ± gpm, the second fueling pump will continue to run and the BPCV will continue modulating to pass flow as necessary to maintain upstream pressure requirement and no additional contol functions will be initiated until system operating conditions change.

4.1.4 If DPT-3H (or DPT-4H) senses a differential pressure corresponding to a flow rate through the return venturi or greater than 700* ± gpm for 15* seconds, the control system will initiate control signals to shut down the second fueling pump.

4.1.5 After refueling the aircraft, operator releases " deadman" control, thus closing the refueling control valve. Operator then disconnects aircraft direct fueling system pantograph from the aircraft.

4.1.6 Upon completion of aircraft refueling operation, the operator depresses "STOP" pushbutton. This stops the lead fueling pump, provided only the lead pump is running, and flow through the return venturi is greater than 560 gpm, and de-energized the BPCV solenoid opening the BPVC. At this point the system has return to an idle, static pressure condition.

4.1.6.1 In the event Operator neglects to press "STOP" pushbutton, the system will automatically stop lead pump and de-energize the BPCV solenoid (opening the BPCV) after 10* minutes, provided only the lead pump is running and flow through the return venturi remains greater than 560 gpm.

4.1.7 In the event a fueling pump is called on and fails to start or fails after successfully starting, as indicated by open contacts on the associated pump discharge flow switch for a ten second interval, the affected fueling pump will be called off and the next fueling pump in the predetermined sequence of pumps will be called on automatically.

4.2 SCHEME "B" REFUELING SEQUENCE OF OPERATION

4.2.1 With the mode selector switch in the "REFUELING" position and pump starter switches in the "AUTO" position, refueling may be initiated at any of the aircraft direct fueling stations. An operator connects a pantograph to an aircraft and depresses the deadman control which hydraulically opens the refueling control valve.

4.2.2 Opening a refueling control valve cause a drop in line pressure detected by pressure indicting transmitter PIT-1 (or PIT-2) set at 60* psig. A PCP output energizes solenoid "A" of the back pressure control valve, BPCV, enabling the valve. A PCP output also energizes the pressure control valve, PCV-1, solenoid forcing the valve to close. If

the low pressure condition remains true for a continuous 10 second interval, the lead pump will start. If the low pressure condition does not remain true for a continuous 10 second interval, the timer will reset and the lead pump will stop and BPCV solenoid "A" will be de-energized, disabling the valve and PVC-1 will open when its solenoid is de-energized.

4.2.3 The lead fueling pump will establish a flow of 600 ± gpm through the system issue venturi and the pressure upstream of the BPCV will increase until the BPCV set point of 80* psig is reached. At this pressure, the BPCV will start to open and the valve will modulate as required to pass sufficient flow through the return venturi to maintain pressure upstream of the valve.

4.2.4 With DPT-1 (or DPT-2) sensing differential pressure corresponding to a flow rate of 600* ± gpm and DPT-3L and DPT-3H (or DPT-4L and DPT-4H) sensing differential pressure corresponding to a flow rate through the return venturi of greater than 40* ± gpm but less than 560* ± gpm, the lead fueling pump will continue to run and the BPCV will continue modulating to pass flow as necessary to maintain the upstream pressure required and no additional control functions will be initiated until system operating conditions change.

4.2.5 If DPT-3H (or DPT-4H) senses a differential pressure corresponding to a flow rate through the return venturi of greater than 560* ± gpm for 60* seconds, the control system will initiate control signals for the following functions. BPCV solenoid "A" will be de-energized to close the BPCV. Signal to stop lead pump will occur when pressure indicating transmitter PIT-1 (or PIT-2) rises above set point of 175* psig, simultaneously PCV solenoid will be de-energized to bleed system pressure to 75* psig, and the lead pump will be stopped.

4.2.6 If DPT-1 (or DPT-2) senses differential pressure corresponding to a flow rate of 600* ± gpm through the issue venturi and DPT-3L and DPT-4L sensing differential pressure corresponding to a flow rate of less than 40 ± gpm through the return venturi for a period of 10 seconds, a second pump will be started.

4.2.7 If DPT-1 (or DPT-2) senses differential pressure corresponding to a flow rate of 1200* ± gpm through the issue venturi and DPT-3L and DPT-3H (or DPT-4L and DPT-4H) sensing differential pressure corresponding to a flow rate greater than 40 ± gpm but less than 700* ± gpm, the lead fueling pump and second fueling pump will continue to run and the BPCV will continue modulating to pass flow as necessary to maintain upstream pressure requirement and no additional control functions will be initiated until system operating conditions change.

4.2.8 If DPT-3H (or DPT-4H) senses a differential pressure corresponding to a flow rate through the return venturi of greater than 700* ± gpm for 15* seconds, the control system will initiate control signals to shut down the second fueling pump, leaving the system to operate as described in paragraph 4.2.4, and shutdown as described in paragraph 4.2.5.

4.2.9 If a fueling pump fails to start or fails after successfully starting, as indicated by open contacts on the pump discharge flow switch for a 10* second interval, the pump will be called off and the next pump in sequence will be started.

4.2.10 If the system is allowed to remain powered in the "REFUELING" mode after a refueling operation, the system will automatically maintain the set minimum pressure. The system loses pressure during idle time periods and the lead pump will be started to re-pressurize the system as described in paragraph 4.2.2 and 4.2.3. After pressurization has been achieved, the system will shutdown as described in paragraph 4.2.5.

4.3 LOOP FLUSHING SEQUENCE OF OPERATION

4.3.1 Place all pump motor starter " HAND-OFF-AUTO" selector switches in the "OFF" position.

4.3.2 Place the mode selector switch on the PCP in the "LOOP FLUSH" position. The solenoid on flushing valve FV will be de-energized and the valve open.

4.3.3 Position manually operated valves in the desired flushing flow path. Start either or all pumps with the starter selector switch in the "HAND" position. If the pumps are to be started locally, transfer the switch interlock key to the desired local "AUTO-HAND" switch at the pump and start the pump locally by placing the switch in the "HAND" position.

4.3.4 If a Scheme "A" fueling system, BPCV solenoid will be de-energized and the valve will be fully open.

4.3.5 If a Scheme "B" fueling system, BPCV solenoids "A" and "B" will be energized and the valve will be fully open.

4.3.6 After the flushing operation has been completed, return the system to the "REFUELING" status by reversing the foregoing procedures. If a Scheme "B" fueling system, the system will be automatically re-pressurized.

4.4 PANTOGRAPH FLUSHING SEQUENCE OF OPERATION

4.4.1 Place all pump motor starter "HAND-OFF-AUTO" selector switches in the "OFF" position.

4.4.2 Place the mode selector switch on the PCP in the "PANTOGRAPH FLUSH" position. The solenoid on flushing valve FV-1 will be energized and the valve fully closed.

4.4.2.1 If a Scheme "A" fueling system, BPCV solenoid will be de-energized and BPCV will fully open.

4.4.2.2 If a Scheme "B" fueling system, BPCV solenoids "A" and "B" will be energized and the valve will fully open.

4.4.3 Position manually operated valves in the system for the desired flow path and connect a pantograph fueling nozzles to the D-1 nozzle adapter.

4.4.4 Select pump to be used for flushing by placing pump starter selector switch in the "AUTO" position for Scheme "A" and start the pump as described in Paragraph 4.4.5. For Scheme "B", place pump starter selector switch in the "HAND" position. This will start pump and close PCV.

4.4.5 If a Scheme "A" system, start pump by depressing "START" pushbutton at the direct fueling stations and depressing fueling hydraulic deadman control. The deadman control must be depressed within a 10* second time interval or the pump will be shutdown by the no flow switch (FS) in the pump discharge line.

4.4.6 For Scheme "A", to stop flushing release the deadman control and depress the "STOP" pushbutton within 10 seconds or pump will be shut down by the no flow switch (FS), and for Scheme "B" place starter selector switch in the "OFF" position.

4.4.7 Repeat steps in paragraphs 4.4.3 through 4.4.6 to flush remaining pantographs.

4.4.8 To return the system to the "REFUELING", reverse the foregoing procedures.

4.5 MANUAL REFUELING SEQUENCE OF OPERATION

4.5.1 If both of the microprocessors in the PCP fail to operate, refueling may be accomplished manually. Precautions should be taken prior to and during a manual operation since operating tank outlet valve position, tank level, and flow switch controls will not be in service. Sufficient tank level for refueling operation should be verified by visual observation. Place selected operating tank inlet and outlet valves in open position.

4.5.2 Place fueling pump starter switches in the "OFF" position.

4.5.3 Manually by-pass the solenoid for BPCV to enable. Scheme "A" system has only one solenoid, by-pass solenoid "A" for Scheme "B" systems. If a Scheme "B" system also disable PCV by closing the manual inlet valve.

4.5.4 Start required fueling pumps by placing the starter switches in the "HAND" position. Stop pumps with same switch.

4.5.5 To return the system to its former status, reverse the foregoing proecdures.

4.6 EMERGENCY FUEL SHUTOFF

4.6.1 Fueling pumps may be shut off, or prevented from starting if not running, and the main fuel discharge line closed when any emergency shutoff station is depressed, control power fails, or a fire alarm occurs. The emergency shutoff system may be manually reset at the PCP only.

4.7 FUELING SYSTEM INTERLOCKS

4.7.1 Outlet valve position limit switches and tank low level switches will prevent pumps from operating unless the outlet valve is fully open and a low fuel level condition does not exist in the selected tanks.

---END OF SECTION---