UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated January 2021
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DIVISION 33 - UTILITIES

SECTION 33 09 53

AVIATION FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (TYPE III)

02/21

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USACE / NAVFAC / AFCEC / NASA	**UFGS-33 09 53 (February 2021)**

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References are in agreement with UMRL dated January 2021

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SECTION 33 09 53

AVIATION FUEL PUMP CONTROL AND ANNUNCIATION SYSTEM (TYPE III)
02/21

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NOTE: This guide specification covers the requirements for the Pump Control and Annunciation System for aircraft refueling systems constructed to the requirements of the DOD Type III Hydrant Refueling System Standards.

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).

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PART 1 GENERAL

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NOTE: NOTE: DoD Type III systems must conform to Standard Design AW 078-24-28 PRESSURIZED HYDRANT FUELING SYSTEM TYPE III. DoD Type IV/V systems must conform to Standard Design AW 078-24-29 PRESSURIZED HYDRANT DIRECT FUELING SYSTEM TYPE IV/V. Cut and Cover systems must conform to Standard Design AW 078-24-33 UNDERGROUND VERTICAL STORAGE TANKS CUT AND COVER. Field fabricated ASTs must conform to AW 078-24-27 ABOVEGROUND VERTICAL STEEL TANKS WITH FIXED ROOFS. Standards can be found on the Whole Building Design Guide at the following location https://www.wbdg.org/ffc/dod/non-cos-standards.

Subject Matter Expert (SME) is defined as Service Headquarters Subject Matter Experts: Air Force - The Air Force Fuels Facilities Subject Matter Expert (HQ AFCEC/COS), Army - Headquarters, U.S. Army Corps of Engineers, POL-MCX Facilities Proponent (CECW-EC) through the Army Petroleum Center (APC), Navy/Marine Corps - NAVFAC POL Facility Subject Matter Expert (NAVFAC EXWC, CI11).
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1.1 REFERENCES

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NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.
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The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C37.90	(2005; R 2011) Standard for Relays and Relay Systems Associated With Electric Power Apparatus
IEEE C62.41	(1991; R 1995) Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

INTERNATIONAL SOCIETY OF AUTOMATION (ISA)

ISA 18.1	(1979; R2004) Annunciator Sequences and Specifications

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(2018) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA IA 2	(2005) Programmable Controllers - Parts 1 thru 8

NEMA ICS 1	(2000; R 2015) Standard for Industrial Control and Systems: General Requirements
NEMA ICS 2	(2000; R 2005; Errata 2008) Industrial Control and Systems Controllers, Contactors, and Overload Relays Rated 600 V
NEMA ICS 4	(2015) Application Guideline for Terminal Blocks
NEMA ICS 6	(1993; R 2016) Industrial Control and Systems: Enclosures

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70	(2020; ERTA 20-1 2020; ERTA 20-2 2020; TIA 20-1; TIA 20-2; TIA 20-3; TIA 20-4) National Electrical Code

U.S. FEDERAL COMMUNICATIONS COMMISSION (FCC)

FCC Part 15	Radio Frequency Devices (47 CFR 15)

UNDERWRITERS LABORATORIES (UL)

UL 508	(2018) UL Standard for Safety Industrial Control Equipment
UL 1012	(2010; Reprint Apr 2016) UL Standard for Safety Power Units Other than Class 2
UL 1449	(2014; Reprint Jul 2017) UL Standard for Safety Surge Protective Devices

1.2 DEFINITIONS

Subject Matter Expert (SME) is defined as Service Headquarters Subject Matter Experts. SME for this project is [Air Force - The Air Force Fuels Facilities Subject Matter Expert (HQ AFCEC/COS)][Army - Headquarters, U.S. Army Corps of Engineers, POL-MCX Facilities Proponent (CECW-EC) through the Army Petroleum Center (APC)][Navy/Marine Corps - NAVFAC POL Facility Subject Matter Expert (NAVFAC EXWC, CI11)].

1.3 ADMINISTRATIVE REQUIREMENTS

a. Section 26 20 00 INTERIOR DISTRIBUTION SYSTEM applies to this section, with the additions and modifications specified herein. The Hydrant Fueling System consists of fueling pumps that pump fuel to a Hydrant Hose Truck Check-out Pad, Truck Fill Stands, and fuel pits located on the airfield apron. Automatic pump starts and stops are based on system pressure and flow.

b. Programmable Logic Controllers (PLCs) receive information from pressure transmitters and other devices to control the pumps and control valves. There are two PLCs that are connected in a redundant configuration, to assure continued operation of the Hydrant fueling System even if either PLC (but not both) fails. The Hydrant Fueling

System also includes above ground fuel storage tanks and a product recovery tank.

c. The pump control panel, personal computer, and annunciator are located in the Control Room of the Pumphouse. The control system must be furnished by a single supplier. See 33 52 43.11 AVIATION FUEL MECHANICAL EQUIPMENT for other required components of the control system. The control system supplier must be responsible for providing a fully functional control system, in accordance with the drawings and specifications, including the field devices. Installation must be in accordance with NFPA 70.

d. Submit six copies of Operation and Maintenance Manuals, within 7 calendar days following the completion of factory tests. Installation, Operation, and Maintenance manuals for all equipment supplied must be furnished following the completion of shop tests and must include:

1). Pump Control Panel including interior and exterior equipment layout. Complete guide outlining step-by-step procedures for system startup and operation.

2). All documents previously submitted and approved with all comments and field changes annotated. Complete description of the sequence of operation including that described in PART 3 and any subsystems not controlled by the PLC (e.g. annunciator panel, EPDS, etc.).

3). Complete listing of all programming of the PLCs, laptop computer, and Personal Computer.

4). Complete relay ladder logic diagrams, PLC input/output diagrams and control power distribution diagrams for the complete control system.

5). Complete troubleshooting guide, which lists possible operational problems and corrective action to be taken, including all as-built conditions.

e. Submit documents demonstrating the accuracy and completeness of the list of material and components, that items proposed comply fully with contract requirements, and are otherwise suitable for the application indicated. Documents must consist of all data or drawings published by the manufacturer of individual items listed including manufacturer's descriptive and technical literature, performance data, catalog cuts, and installation instructions. Submit additional material if the listed items are not adequate to identify intent or conformance to technical requirements. Provide typed and electronic copies of these lists for approval. Any delays associated with resubmittals of incomplete or ambiguous initial submittals will be the Contractor's responsibility.

f. For hard copy submittals, documents must be bound in a suitable binder adequately marked or identified on the spine and front cover. A table of contents page must be included and marked with pertinent contract information and contents of the manual. Provide tabs to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare parts data. Index sheets must be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers.

1.4 SUBMITTALS

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NOTE: Review submittal description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item, if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force and NASA projects, or choose the second bracketed item for Army projects.

****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Shop Drawing; G[, [_____]].

SD-03 Product Data

Pump Control Panel (PCP) and Components; G[, [_____]]

Programmable Logical Controller (PLC) Hardware and Software; G[, [_____]].

Personal Computer (PC); G[, [_____]]

Laptop Computer; G[, [_____]]

FCC Computer; G[, [_____]]

Laser Printer; G[, [_____]]

Graphics Display Screen; G[, [_____]]

Control Wiring Data Lists; G[, [_____]]

Tools and Spare Parts

SD-06 Test Reports

Certified Pump Control Panel (PCP) Shop Test Report

Record of Test

SD-07 Certificates

Experience and Qualifications; G[, [_____]]

Training Plan for Instructing Personnel; G[, [_____]]

Testing Plan; G[, [_____]]

SD-10 Operation and Maintenance Data

Operation and Maintenance Manuals; G[, [_____]]

1.5 TOOLS AND SPARE PARTS

Provide the following:

a. Any special tools necessary for operation and maintenance of the equipment providing supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked.

b. One spare set of fuses of each type and size

c. Recommended manufacturer list of spare parts, including part number, current unit price, and source of supply.

d. One spare power supply module

e. One spare I/O module for discrete devices and one for analog devices

f. Two PLC RAM back-up batteries

g. Two complete sets of ink cartridges for the laser printer

h. Minimum of 10 spare lamps for the Alarm Annunciator

i. Minimum of 10 spare lamps of each type of non-LED lamps used on the Pump Control Panel

1.6 EXPERIENCE AND QUALIFICATIONS

Submit the following data for approval:

a. Certification stating that the manufacturer has manufactured, installed, and successfully completed at least five PLC-based systems for automatic cycling of pumps based upon varying dispensing demands ranging from 0 to 182 L/s 0 to 2400 GPM utilizing multiple pumps. At least two of the five PLC-based systems must be for dispensing jet fuel into a pressurized, constant pressure, flow demand aircraft hydrant system.

b. Certification that the control systems have successfully operated over the last 2 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.

1.7 WARRANTY

The Pump Control and Annunciation System including devices, hardware and software must be warranted for a period of one year from the date of acceptance of the system by the Government. This warranty service must include parts and labor service for equipment supplied under this specification. Upon notification by the Government of system or component failure, respond at the site with necessary parts within 48 hours of notification.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

2.1.1 Pump Control Panel (PCP) and Components

NEMA ICS 1, NEMA ICS 6, NEMA 250, and UL 508. The PCP enclosure must be a freestanding NEMA Type 12, smooth, gasketed enclosure constructed of 12 gauge steel. All seams must be continuously welded. All drilled holes or knockouts must be performed after delivery to the job site. The pump control panel dimensions must be a maximum of 2.3 m 90 inches high, maximum 1.8 m 72 inches wide, and a maximum of 610 mm 24 inches deep and must have removable lifting eyes. The interior surfaces of the panel must be properly cleaned, primed, and spray painted with white high-gloss enamel. Exterior surfaces must have standard factory finish. Access for the PCP must be front only and must consist of hinged doors having 3-point latching mechanisms. The doors must open approximately 120 degrees. Rack mounting angles, swing-out panels and other component mounting hardware must be installed such that servicing of one component must not require removal or disconnection of other components. No clearance must be required between the back of the panel and the room walls. Terminal facilities must be arranged for entrance of external conductors from the top or bottom of the enclosure.

2.1.2 Ventilation System

Provide two supply fans, single phase, 115 volt. Each fan must supply a minimum of 47 L/s 100 CFM. The supply and exhaust grill must contain a filter that is easily removed from the exterior of the enclosure. Also provide three thermostats with an adjustable set point range of 21 degrees C70 degrees F to 60 degrees C 140 degrees F. Locate the thermostats near the top in the interior of the PCP.

2.1.3 Ground Bar

The control panel must have a tin plated copper equipment ground bar. The bar must have a minimum of twenty grounding screws.

2.1.4 Standard Indicator Lights

NEMA ICS 1, NEMA ICS 2, and UL 508. Lights must be heavy duty, NEMA 13, 22.5 mm 1 inch mounting hole, round indicating lights operating at 120 volts ac/dc or 24 volts ac/dc. Long life bulbs must be used. Indicator lights must have a legend plate with words as shown on drawings. Lens color as indicated on the drawings. Lights must be "push to test (lamp)" type. LED type lamps of comparable size and color may be substituted for standard indicator lights.

2.1.5 Selector Switches

NEMA ICS 1, NEMA ICS 2, and UL 508. Non-illuminated lever operated selector switches must be heavy duty, NEMA 13, round, and utilize a 22.5 mm 7/8 inches mounting hole. They must have the number of positions as indicated on the drawings. Switches must be rated 600 volt, 10 amperes continuous. Legend plates must be provided with each switch with words as indicated on the drawings.

2.1.6 Pushbuttons

NEMA ICS 1, NEMA ICS 2, and UL 508. Non-illuminated pushbuttons must be heavy duty, NEMA 13, round, utilize a 22.5 mm 7/8 inch mounting hole, and have the number and type of contacts as indicated on the drawings or elsewhere in the specifications. The emergency stop switch must be a red mushroom head, 38 mm 1.5 inch diameter, momentary contact type. Pushbuttons must be rated 600 volt, 10 amperes continuous. Legend plates must be provided with each switch with words as indicated on the drawings.

2.1.7 Relays

IEEE C37.90, NEMA ICS 2, UL 508.

2.1.8 Nameplates

Nameplates must be made of laminated plastic with black outer layers and a white core. Edges must be chamfered. Nameplates must be fastened with black-finished round-head drive screws or approved nonadhesive metal fasteners.

2.1.9 Transient Voltage Surge Suppression Devices

IEEE C62.41 for Category "B" transients, UL 1449.

2.1.10 Terminal Blocks

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

2.1.11 Circuit Breakers

UL 508. Individual, appropriately sized, terminal block mounted, circuit breakers must be provided for all 120 volt PCP mounted equipment and for the 120 volt terminal boards shown on the drawings.

2.1.12 Uninterruptible Power Supplies

UL 1012. Input voltage must be 120 volts (nominal), 1 phase, 60 Hertz. Output voltage regulation must be +/-5.0 percent for the following conditions:

a. 20 to 100 percent load on output.
b. Input voltage variation of -15 to +10 percent.
c. Constant load power factor between 80 and 100 percent.

Response time must be 1.5 cycles or less. Battery capacity must be such as to provide an orderly shut down of operating programs or as a minimum 30 minutes.

2.1.13 Miscellaneous Power Supplies

UL 1012. Certain field devices may require power other than 120 VAC (i.e. 24 VDC). The power supplies must be convection cooled, have fully isolated independent outputs, have constant voltage, have short circuit and overvoltage protection, and have automatic current limiting.

2.1.14 Alarm Annunciator

UL 508 and ISA 18.1. The Alarm Annunciator must provide visual annunciation, local and remote monitoring, constant or flashing visual and audible alarm as specified herein. The annunciator must be completely solid state with no moving parts. The annunciator must be furnished with cabinet and hardware appropriate for flush mounting on the control panel. A power supply either integral or separately mounted must operate on 120 volts, 60 Hertz. The annunciator must have windows arranged in a matrix configuration (rows and columns). Each window must be at least 24 mm 15/16 inch high by 40 mm 1-5/8 inches wide and must have rear illuminated translucent engraved nameplate. Lettering must be at least4 mm5/32 inches high. System lamp voltage must be 24 to 28 volts dc. The cells must be individually addressable and not hardwired.

2.1.15 Alarm Horns

UL 508. The alarm horns must consist of 3-vibrating horns and 2-resonating horns. One vibrating horn is to be mounted in the PCP, and two vibrating and two resonating horns must be mounted outside of the pumphouse as shown on the drawings. The exterior horns must each produce 100 db at 3 m 10 feet and must be provided in a weather proof housing. The PCP horn must produce 70 db at 3 m 10 feet.

2.1.16 Laptop Computer

2.1.16.1 Hardware

The following are the minimum hardware requirements for the laptop computer:

a. Latest Pentium CPU operating at 2 GHz or faster
b. 2 GB RAM
c. 500 GB hard drive
d. 8X Read Write DVD drive
e. Color LCD screen 356 mm14 inches
f. Keyboard
g. Pointing device (e.g. mouse)
h. Parallel communication port
i. Serial communication port compatible with PLC (e.g. RS-232-C, RS-485)
j. 120VAC and Battery power supply
k. All cables and connectors for interfacing with PLC and personal computer
l. Modem compatible for remote troubleshooting of the system
m. Two USB 2.0 communications ports
n. Provide a carrying case for the Laptop Computer

2.1.16.2 Software

The following is the minimum software to be loaded on the laptop. The software must be the most current versions and compatible with each other to make a complete and usable system. All software needs to be fully site licensed and come with all disks to allow a full restore or reload of software in the event of a hard drive crash.

a. Operating system (e.g. the latest commercially available MS Operating system)
b. Software for programming the PLCs
c. Software for programming the personal computer

2.1.17 Personal Computer (PC)

2.1.17.1 Hardware

The following are the minimum hardware requirements for the personal computer:

a. Latest Pentium CPU operating at 3.2 GHZ or faster
b. 4 GB RAM
c. 500 GB hard drive
d. 16X Read Write DVD drive
e. Color 610 mm 24 inches flat screen monitor
f. Keyboard
g. Pointing device (e.g. mouse)
h. Parallel communication port
i. Serial communication port compatible with PLC (e.g. RS-232-C, RS-485)
j. 120 VAC operating power
k. All cables and connectors interfacing with PLC and Laser Printer
l. Provide a modem capable of remote troubleshooting of the system. The modem will not be permanently connected to the System
m. Two USB 2.0 communications ports

2.1.17.2 Software

The following is the minimum software to be loaded on the personal computer. The software must be the most current versions and compatible with each other to make a complete and usable system. All software needs to be fully site licensed and come with all disks to allow a full restore or reload of software in the event of a hard drive crash.

a. Operating system (e.g. the latest commercially available MS Operating

System)

b. Software for programming the PLCs

c. The personal computer must communicate with the PLCs to display system status and change system set points. The personal computer must have run-time graphical software to display the graphical screens described later and to change set points

d. Software for recording, tracking, trending, and printing out the pressures, flows, and operational status of all monitored components of the fueling system on a real time basis

e. Provide MS Office Professional with Excel to allow the trending data described above to be imported to Excel where it can be studied, manipulated, graphed, and easily sent electronically

2.1.18 Laser Printer

Provide color laser jet alarm/report printer. The unit must print in black at a minimum speed of twelve pages per minute. It must print in color at a minimum speed of ten pages per minute. As a minimum print color graphs of various system pressures, issue flow, and return flow vs. time in seven colors. Provide one set of spare replacement ink cartridges.

2.1.19 FCC Computer

2.1.19.1 Hardware

The FCC computer must be a copy of the personal computer so that upon failure of the personal computer it could be relocated to the pumphouse to assume the personal computers duties. The normal duties of the FCC computer must be to serve as a remote monitor only of the screens that are available on the personal computer. The following are the minimum hardware requirements for the FCC computer:

a. Latest Pentium CPU operating at 3.2 GHZ or faster
b. 4 GB RAM
c. 500 GB hard drive
d. 16X Read Write DVD drive
e. Color 610 mm 24 inch flat screen monitor
f. Keyboard
g. Pointing device (e.g. mouse)
h. Parallel communication port
i. Serial communication port compatible with PLC (e.g. RS-232-C, RS-485)
j. 120 VAC operating power
k. All cables and connectors interfacing with PLC and Laser Printer
l. Provide a modem capable of remote troubleshooting of the system. The modem will not be permanently connected to the System
m. Two USB 2.0 communications ports

2.1.19.2 Software

The following is the minimum software to be loaded on the FCC computer. The FCC computer must be capable of replacing the Personal computer in the pumphouse if the personal computer fails. It will be set up initially to serve only as a remote monitor of the system while located at the FCC. Should the personal computer fail, the FCC computer will be relocated to the pumphouse and then assume the role of the personal computer. The

computer software must have a built in command to tell the computer whether it is serving as the personal computer or as the remote monitor only. The software must be the most current versions and compatible with each other to make a complete and usable system. All software needs to be fully site licensed and come with all disks to allow a full restore or reload of software in the event of a hard drive crash.

a. Operating system (the latest commercially available MS Operating System)

b. Software to tell the computer which mode it is to operate in, i.e. (personal computer or remote monitor)

c. Software to run as a remote monitor

d. Software for programming the PLCs

e. The personal computer must communicate with the PLCs to display system status and change system set points. The personal computer must have run-time graphical software to display the graphical screens described later and to change set points

f. Software for recording, tracking, trending, and printing out the pressures, flows, and operational status of all monitored components of the fueling system, on a real time basis

g. Provide MS Office Professional with Excel to allow the trending data described above to be imported to Excel where it can be studied, manipulated, graphed, and easily sent electronically

2.2 PROGRAMMABLE LOGICAL CONTROLLER (PLC) HARDWARE AND SOFTWARE

2.2.1 General

a. NEMA IA 2. Each PLC must be able to receive discrete and analog inputs and through its programming it must control discrete and analog output functions, perform data handling operations and communicate with external devices and remote I/O racks. The PLCs must be a modular, field expandable design allowing the system to be tailored to the process control application. The capability must exist to allow for expansion to the system by the addition of hardware and/or user software. At a minimum the PLCs must include mounting backplanes, power supply modules, CPU module, communication modules, and I/O modules.

b. Design and test each PLC provided for use in the high electrical noise environment of an industrial plant. The PLC modules must comply with the FCC Part 15 Part A for radio noise emissions. The programmable controller processor must be able to withstand conducted susceptibility tests as outlined in NEMA ICS 2, IEEE C37.90.

c. The PLCs must function properly at temperatures between 0 and 50 degrees C 32 and 122 degrees F, at 5 to 95 percent relative humidity non-condensing and have storage temperatures between-40 to +60 degrees C-40 and +140 degrees F at 5 to 95 percent relative humidity non-condensing.

d. The PLCs must have manufacturer's standard system status indicators (e.g. power supply status, system fault, run mode status, back-up battery status).

2.2.2 Central Processing Unit Module

The CPU must be a modular self-contained unit that will provide time of day, scanning, application (ladder rung logic) program execution, storage of the application program, storage of numerical values related to the application process and logic, I/O bus traffic control, peripheral and external device communications and self-diagnostics.

2.2.3 Power Supply Module

a. The power supply module must be plugged into the backplane not separately mounted. The power supply must be wired to utilize 120 VAC, 60 Hz power, the system must function properly within the range of -10 to +15 percent of nominal voltage. The power supply must provide an output to the backplane at a wattage and voltage necessary to support the attached modules. A single main power supply module must have the capability of supplying power to the CPU module and local communication and I/O modules. Auxiliary power supplies must provide power to remote racks.

b. Each power supply must have an integral on/off disconnect switch to the module. If the manufacturers standard power supply does not have an on/off disconnect switch a miniature toggle type switch must be installed near the PLC and clearly labeled as to its function.

c. The power supply must monitor the incoming AC line voltage for proper levels and have provisions for both over current and over voltage protection. If the voltage level is detected as being out of range the system must have adequate time to complete a safe and orderly shutdown.

2.2.4 Program Storage/Memory Requirements

a. The PLC must have the manufacturers standard nonvolatile executive memory for the operating system. The PLC must also have EEPROM (Electrically Erasable Programmable Read Only Memory) for storage of the user program and battery backup RAM for application memory. The EEPROM must be loaded by use of the laptop computer or the personal computer.

b. Submit a calculation of the required amount of EEPROM and RAM (random access memory) needed for this application plus an extra 50 percent.

c. The number of times a normally open (N.O.) and/or normally closed (N.C.) contact of an internal output can be programmed must be limited only by the memory capacity to store these instructions.

2.2.5 Input/Output (I/O) Modules

a. Provide all required I/O modules (analog input, analog output, discrete input, discrete output, and isolated discrete output) to manipulate the types of inputs and outputs as shown on the drawings and to comply with the sequence of operations. Also provide a minimum of 20 percent (round up for calculation) spare input and output points of each type provided, but not less than 2 of each type.

b. I/O modules must be a self-contained unit housed within an enclosure to facilitate easy replacement. All user wiring to I/O modules must be through a heavy-duty terminal strip. Pressure-type screw terminals

must be used to provide fast, secure wire connections. The terminal block must be removable so it is possible to replace any input or output module without disturbing field wiring.

c. During normal operation, a malfunction in any remote input/output channel must affect the operation of only that channel and not the operation of the CPU or any other channel.

d d. Isolation must be used between all internal logic and external power circuits. This isolation must meet the minimum specification of 1500 VRMS. Provide optically isolated I/O components which are compatible with field devices.

e. Each I/O module must contain visual indicators to display ON/OFF status of individual input or output points.

f. Discrete output modules must be provided with self-contained fuses for overload and short circuit protection of the module.

g. All input/output modules must be color coded and titled with a distinctive label.

2.2.6 Interfacing

The PLC must have communication ports and communication modules using the manufacturers standard communication architecture for connections of the Personal computer, Laptop Computer, remote I/O racks and interconnections between SYS 1 PLC and SYS 2 PLC for the redundant backup system of the PLCs.

2.2.7 Program Requirements

a. The programming format must be ladder diagram type as defined by NEMA IA 2.

b. There must be a means to indicate contact or output status of the contact or output on the LCD (of the personal computer) or LCD screen (of the laptop computer). Each element's status must be shown independently, regardless of circuit configuration.

c. The program must be full featured in its editing capabilities (e.g. change a contact from normally open to normally closed, add instructions, change addresses, etc.).

2.2.8 Diagnostics

The CPU must continuously perform self-diagnostic routines that will provide information on the configuration and status of the CPU, memory, communications and I/O. The diagnostic routines must 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. The CPU must log I/O and system faults in fault tables, which must be accessible for display. When a fault shuts down a CPU, a sequence must be initiated that will automatically switch over to the other CPU. When a fault affects I/O or communication modules the CPU must shut down only the hardware affected and continue operation by utilizing healthy system components. All faults must be annunciated on the alarm annunciator.

PART 3 EXECUTION

3.1 PUMP CONTROL PANEL (PCP) AND COMPONENTS

3.1.1 General

a. Where two or more pieces of equipment performing the same function are required, they must be exact duplicates produced by the same manufacturer. All display instruments of each type must 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.

b. The PCP must include all required resident software programs and hardware to provide the specified sequence of operation. All software optical discs, including programming manuals, must be turned over to the Government at the completion of start-up so modification can be done in the field with no outside assistance.

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

d. The PCP must be shipped fully assembled in one piece after the completion of the shop tests and all defects corrected.

3.1.2 Wiring

Wiring methods and practices must be in conformance with NEMA ICS 1, NEMA ICS 2, NEMA ICS 4, and NEMA ICS 6 recommendations as applicable. All wiring to instruments and control devices must be made with stranded wire, and wiring must be permanently labeled with conductor/wire numbers within 1 inch of termination points. Labels must be tubular heat-shrinkable wire markers that remain legible after exposure to industrial fluids and abrasion. Position markers so that wire numbers can be read without disturbing or disconnecting wiring. Use of individual character-markers placed side-by-side is not acceptable. Numbers must match approved shop drawings. All wiring must be neatly laced from point of entry into enclosures to termination points with nylon lacing cord or plastic lacing ties. Lacing within wiring channels is not required. Provide typed Control Wiring Data Lists within each terminal cabinet and the PCP. The data lists must include: conductor identification number, wire gauge, wire insulation type, "FROM" terminal identification, "TO" terminal identification, and remarks. The preliminary lists generated by the Contractor will be submitted for approval to the Contracting Officer and will be updated to As-Built conditions by the Contractor. The As-Built data lists must be placed in a document holder within each enclosure for both hard copy and electronic submittal.

3.1.3 Certified Pump Control Panel (PCP) Shop Test Report

The manufacturer must shop test the PCP, Personal computer, and lap top computer. The procedure must include simulation of field components and must provide for fully testing the pump control and annunciator system as a unit before delivery to the project site. The test must, 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 misapplication of components. The test must be performed prior to shipment to the site and problems detected must be corrected. The final testing and correction sequence must be repeated until no problems are revealed and then two additional successful tests must be performed. Submit certified test report within 15 days after completion of the test. The report must include a statement that the Pump Control Panel performs as specified. Notify the Contracting Officer and the SME 30 days prior to the final shop testing date. The Contracting Officer may require a Government witness at the final test before the PCP is shipped to the site.

3.1.4 Ventilation System

Thermostat T-1, must control fan F-1 and thermostat T-2 must control fan F-2. T-1 and T-2 must be set at 27 degrees C 80 degrees F to maintain interior air temperature to -7 degrees C 20 degrees F above ambient. Thermostat T-3, set at 38 degrees C 100 degrees F, must provide a non-critical PCP HIGH TEMPERATURE alarm to the alarm annunciator.

3.1.5 Grounding

The PCP ground bar must be connected to the building counterpoise via a #10 AWG conductor. Within the enclosure all I/O racks, processor racks, and power supplies, etc. must be grounded to meet the manufacturer's specifications.

3.1.6 Indicator Lights, Switches, and Pushbuttons

Indicator lights, switches, and pushbuttons must be mounted through the PCP enclosure and must be arranged to allow easy vision and operation of each device. Each device must have a nameplate and/or legend plate as indicated on the drawings. Nameplate wordings must be as indicated on the drawings.

3.1.7 Transient Voltage Surge Suppression Devices

Transient voltage surge suppression (TVSS) devices must be installed in the PCP to minimize effects of nearby lightning strikes, switching on and off of motors and other inductive loads. TVSS must be provided for each control circuit ladder. Each ladder may contain any combination of the following devices: PLCs, power supplies (e.g., 24 volt), fans, relays, lights, switches etc. TVSS must also be provided for PLC I/O originating outside of the building.

3.1.8 Terminal Blocks

As a minimum, any PCP device that connects to a field device (devices not located in the PCP) must be connected to a terminal block. A connection diagram similar to the drawings must be provided to the field Contractor for field connections to the PCP.

3.1.9 Circuit Breakers

As a minimum, any 120 volt PCP device i.e. (fans, lights, power receptacles, 24 VDC power supplies, PLC CPUs, PLC I/O racks) must be provided with an individual circuit breaker. Additionally 120 volt terminal boards connecting to field devices (devices not located in the PCP) must be protected by a 120 volt circuit breaker.

3.1.10 Uninterruptible Power supplies

The PCP must contain three uninterruptible power supplies (UPS) each connected to a dedicated circuit. As shown on the drawings one UPS must supply PLC System 1, one UPS must supply PLC System 2, and the third UPS must supply the miscellaneous device power. The UPSs output capacity must be sufficient to drive all the equipment connected plus 25 percent. The UPSs must be mounted on shelves near the bottom of the PCP but not rest on the floor of the PCP.

3.1.11 Power Supplies

Provide and install all 120 VAC and 24 VDC power supply. Interconnecting wiring between UPSs and PLC power supplies must be completely installed prior to shipment to the job site.

3.1.12 Alarm Annunciator and Horns

Signals must be initiated by hardwired field contacts or by PCP outputs as required. The annunciator must energize alarm horns, both an integral panel mounted vibrating horn and remote horns, and flash the appropriate annunciator lamp. The minimum number of windows must correspond to the number of alarm points, plus 15 percent spare. The drawings indicate panel layout and the alarms to be annunciated.

3.1.12.1 Non-critical Alarms

Non-critical alarm windows must be white with black lettering and must sound the PCP mounted vibrating horn and the exterior mounted vibrating horns.

3.1.12.2 Critical Alarms

Critical alarm windows must be red with white lettering and must sound the PCP mounted vibrating horn and the exterior mounted resonating horns. Critical alarms must also cancel all automatic pump starts in the PLC.

3.1.12.3 Alarm Sequence

Alarm sequence for each alarm must be as follows (ISA 18.1 sequence 'A').

a. For a normal condition, visual indicator and horns will be off.

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

c. Upon acknowledgment of the alarm condition, visual indicator will be steady on and the horns will be off.

d. If, after acknowledgment of an alarm condition, another alarm condition is established, the new alarm 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.

3.1.13 Personal Computer

The personal computer must be a stand alone, desk top mounted unit. The personal computer must download system parameters from the PLCs for display. The personal computer must also upload new set point values that the operator has changed using the personal computer keyboard, after a password has been entered.

3.1.13.1 Screen Number 1

This must be a general opening screen. As a minimum it must display the name and location of the installation (e.g. Seymour Johnson Air Force Base, North Carolina), name of the project (e.g., Type III Hydrant Fueling System) and screen navigation information.

3.1.13.2 Screen Number 2

At a minimum the following items must be displayed. The values must be continuously updated, a 2 second delay maximum between updates will be acceptable.

System Issue Rate	xxxx L/sGPM
System Return Rate	xxxx L/sGPM
System Net Flow	xxxx L/sGPM
System Pressure	xxxx kPaPSI
System Operation Mode	Auto/Off/Flush/Tightness test
Active System	Sys-1/Sys-2
Lead Pump	1/2/3/4/5
Fuel Pump #1	On/Off xxxxx.x HOURS
Fuel Pump #2	On/Off xxxxx.x HOURS
Fuel Pump #3	On/Off xxxxx.x HOURS
Fuel Pump #4	On/Off xxxxx.x HOURS
Fuel Pump #5	On/Off xxxxx.x HOURS
Backpressure Control Valve	Closed/Enabled
Pressure Control Valve	Closed/Enabled

Defuel/Flush Valve	Closed/Enabled
Tank 1 Outlet Valve	Open/Closed
Tank 2 Outlet Valve	Open/Closed
Tank 1 Receipt Valve	Open/Closed
Tank 2 Receipt Valve	Open/Closed
Receipt Bypass Valve	Open/Closed
Manifold Setup Valve I34	Open/Closed
Manifold Setup Valve I35	Open/Closed
Manifold Setup Valve R10	Open/Closed
Manifold Setup Valve R11	Open/Closed
Only one of the words separated by a slash (/) must be displayed. The xxxxx.x HOURS is the fuel pumps elapsed run time and the value must not be lost when the lead PLC is switched. The pump and valve status words must be color coded to match the colors used on the graphic display screen.	

3.1.13.3 Screen Number 3

The following table must be displayed. The table lists the set points that can be adjusted using the operator interface. A password must be entered before the "current value" can be adjusted. The value entered can only be a number within the "set point range". The "default value" is the value held in the program that is loaded into EEPROM memory (This screen may require more than one display screen.).

SET POINT DESCRIPTION	SET POINT RANGE	DEFAULT VALUE	CURRENT VALUE
Lead pump starting pressure	205 to 1035 kPa30 to 150 psi	415 kPa60 psi	xxx KpApsi

SET POINT DESCRIPTION	SET POINT RANGE	DEFAULT VALUE	CURRENT VALUE
Issue flow to start second pump in the sequence	25 to 40 L/s450 to 650 gpm	35 L/s560 gpm	xxx L/sgpm
Issue flow to start third pump in the sequence	65 to 80 L/s1000 to 1300 gpm	73 L/s1160 gpm	xxx L/sgpm
Issue flow to start fourth pump in the sequence	100 to 120 L/s1600 to 1900 gpm	111 L/s1760 gpm	xxx L/sgpm
Return flow to enable next pump in sequence to start	0.5 to 6 L/s10 to 100 gpm	2.5 L/s40 gpm	xxx L/sgpm
Return flow to stop fourth, third, and second pump in the sequence (lag pump)	30 to 50 L/s500 to 800 gpm	35 L/s560 gpm	xxx L/sgpm
Return flow to initiate lead pump shutdown sequence	30 to 50 L/s500 to 800 gpm	35 L/s560 gpm	xxx L/sgpm
Timer to enable start-up of lead pump	0 to 120 seconds	0 seconds	xx seconds
Timer to enable second, third and fourth pumps to start	0 to 120 seconds	10 seconds	xx seconds
Timer to stop fourth, third, and second pumps	0 to 120 seconds	15 seconds	xx seconds
Timer to stop first pump	0 to 60 seconds	2 seconds	xx seconds
Timer to disable Back Pressure Control Valve	0 to 360 seconds	60 seconds	xx seconds
Timer to establish fueling pump failure	5 to 30 seconds	15 seconds	xx seconds
System pressure to stop lead pump	895 to 1310 kPa130 to 190 psig	965 kPa140 psig	xxx kPapsig

3.1.13.4 Screen Number 4

This screen must be a duplicate of the Graphic Display Drawing showing a schematic of the process flow. This screen must be referred to as the graphical display. Many operating parameters must be displayed here as required in later paragraphs of this specification.

3.1.13.5 Screen Number 5

This screen must be a duplicate of the Alarm Annunciator and it must be superimposed over the current active screen on the personal computer monitor when an alarm is activated.

3.1.13.6 Screen Number 6

This screen must be a screen designed solely for assisting the testing team during initial start up to watch all of the significant parameters of the systems operation simultaneously on one screen. This screen must include the system parameters i.e. (flows, pressures, and status) from screen 2, the set points from screen 3, and timers for all of the actions that will take place following a delay function.

3.1.13.7 Screen Number 7

This screen must be a screen designed solely for displaying the seven graphs as described in Section 33 08 53 AVIATION FUEL DISTRIBUTION SYSTEM START-UP. The following values must be displayed concurrently against time: Issue flow, Issue pressure, Return flow, Pump #1 discharge pressure, Pressure upstream of BPCV, Pressure downstream of BPCV, and Hydrant Pit Pressure. The personal computer must be capable of storing up to 1 week of data corresponding to the above values. The system will be able to produce graphs on the screen of this data and be able to print the data in seven colors on the laser printer.

3.1.13.8 Screen Number 8

This screen must be an alarm history screen. This screen must be referred to as the Alarm History Display. This screen must be capable of storing and displaying all alarms that have occurred in the system for at least a period of 30 days.

3.1.13.9 Screen Number 9

This screen must be a screen designed solely for displaying the parameters and process involved in the Tightness Test as described in this specification and on the drawings. The following values must be displayed concurrently against time: Pressure (as sensed by PIT3). The system will be able to produce graphs on the screen of this data and be able to print the data in color on the laser printer.

3.1.14 Laptop Computer

The Laptop computer must be used to create, edit, and load the ladder logic program into the PLCs and the operator interface graphics control program into the personal computer. The Laptop must also be used to monitor the PLCs memory and ladder logic program. The computer must be stored in a lockable cabinet located within the Pump Control Panel.

3.2 PROGRAMMABLE LOGICAL CONTROLLER (PLC) HARDWARE AND SOFTWARE

3.2.1 General

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NOTE: The pressure indicating transmitters and the differential pressure transmitters are the only devices that the PLC can monitor for a possible failure. Failures are defined in the following manners: When the pressure indicating transmitters differ with each other by more than 69 kPa 10 psig after a 10 second delay, assume the lower reading transmitter has failed. When the issue differential pressure transmitters differ from each other by more than 2 L/s 30 gpm after a ten second delay, assume the lower reading transmitter has failed. When the return differential pressure transmitters differ from each other by more than 1.5 L/s 20 gpm after a ten second delay, assume the lower reading transmitter has failed.

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The basic operation of the redundant PLC system is (Reference "Control System Block Diagram" on the drawings):

a. CPU-1 and it's associated I/O rack (I/O-1) sends system outputs to appropriate devices and receive input signals from System-1 redundant field devices (PIT-1, DPT-1, DPT-3, flow switches, valve limit switches), System-2 redundant field devices (PIT-2, DPT-2, DPT-4, flow switches, valve limit switches), and all nonredundant field devices as listed on the drawings.

b. CPU-2 and it's associated I/O rack (I/O-2) sends system outputs to appropriate devices and receive input signals from System-1 redundant field devices (PIT-1, DPT-1, DPT-3, flow switches, valve limit switches), System-2 redundant field devices (PIT-2, DPT-2, DPT-4, flow switches, valve limit switches), and all nonredundant field devices as listed on the drawings.

c. Within each rack (I/O-1 and I/O-2) System-1, System-2, and nonredundant inputs and outputs must not be mixed on the same input/output module.

d. Under normal operation: The system input select switch is in the "SYS-1" position. CPU-1 is controlling the system using System-1 and nonredundant inputs from I/O-1 and any set point changes from the personal computer. CPU-2 is being updated by CPU-1 or concurrently monitoring System-1 inputs from I/O-2.

e. If under normal operation CPU-1 recognizes that a System-1 input has failed (see note below) it must change over to the System-2 redundant input on I/O-1 and report the failure to the personal computer alarm screen.

Note: The pressure indicating transmitters and the differential pressure transmitters are the only devices that the PLC can monitor for a possible failure. Failures must be defined in the following manners: When the pressure indicating transmitters differ from each other by more than 69 kPa 10 psig after a ten second delay, assume the lower reading transmitter has failed. When the issue differential pressure transmitters differ from

each other by more than 2 L/s 30 gpm after a ten second delay, assume the lower reading transmitter has failed. When the return differential pressure transmitters differ from each other by more than 1.5 L/s 20 gpm after a ten second delay, assume the lower reading transmitter has failed.

f. During normal operation there are two ways for CPU-2 to take control of the system: 1) CPU-1 identifies its own internal fault and hands over control to CPU-2. 2) CPU-2 identifies a fault in CPU-1 and takes control from CPU-1. When CPU-2 is in control of the system it must annunciate the fault condition and must be using any updated inputs from the personal computer and must use System-1 inputs. If CPU-2 senses a fault on a System-1 input it must then switch over to the appropriate System-2 input. If power is lost to System-1 inputs then CPU-2 must use all of the System-2 inputs.

g. CPU-2 must also report any of its internal faults to CPU-1 and CPU-1 must report any faults it detects in CPU-2.

h. When the operators think the system is not working and the PLCs do not detect any faults the operator can move the system input select switch from the "SYS-1" position to the "SYS-2" position. With the switch in the "SYS-2" position the PLCs are using System-2 inputs.

3.2.2 Programs

a. Provide two copies of all working programs (i.e. PLC logic, personal computer) on read only optical discs as well as a printed program listing.

b. Provide rung comments (documentation) in the ladder logic program. Each device, on the ladder, must be identified as to the type of device, i.e. limit switch XX, flow indicator XX, motor starter XX, etc. Rung comments must be provided for input and output rungs. The programmer must also provide a comment describing the function of each rung or group of rungs that accomplish a specific function.

3.3 GRAPHICS DISPLAY SCREEN

3.3.1 General

The graphic display screen must be capable of being displayed on the personal computer monitor.

3.3.2 Display Presentation

The Graphic Display must depict the process fuel flow schematically as indicated on the drawings. Red, green, and amber symbols must be integrated with the process schematic to provide current equipment status graphically. The symbols must be located immediately adjacent to related equipment symbol.

3.3.3 Process Schematic

The process schematic graphic representation must utilize conventional symbols when possible. Symbols and flow lines must be sized and spaced so as to provide a clear representation of the system process. The Graphic Display must be suitable for supervised field modification when future items are added. Minor changes may be incorporated to allow proper line width and spacing. Component arrangement, piping routing, and location of

valves must match the flow diagram. The Graphic Display layout must be approved by the Government.

3.3.4 Digital Flow and Pressure Indicators

The graphics display screen must have digital displays for the flows and pressures as indicated on the drawings.

3.4 INSTALLATION

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

3.4.1 Shop Drawing

The shop drawing must be clear and readable and preferably drawn using a computer aided drafting package. At the conclusion of the project the diagram drawings must be redrafted to include all as-built conditions. These updated drawings must be included in the O&M Manuals and appropriate section of the drawings placed in a data pocket located in each of the enclosures. The shop drawing at a minimum must show:

a. Overall dimensions, front, side and interior elevation views of the PCP showing size, location and labeling of each device.

b. Overall dimensions, front elevation of the GDP showing graphical layout and size, location and labeling of each device.

c. Power ladder diagram indicating power connections between TVSS, power conditioners, PLCs, power supplies and field and panel devices. Any terminal block connection numbers used must be indicated.

d. Control ladder diagram indicating control connections between field and devices and PLC I/O modules. Terminal block connection numbers and PLC terminal numbers must be indicated.

e. Communication connections between PLCs and I/O racks. Communication channel numbers must be indicated.

f. Bill of materials.

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

3.4.2 System Start-Up and Testing

a. At PCP start-up and testing provide personnel, onsite, to provide technical assistance, program fine tuning, and to start-up and test the system. Start-up and testing must be coordinated with the overall fueling system start-up test specified in Section 33 08 53 AVIATION FUEL DISTRIBUTION SYSTEM START-UP. Prior to this test, all connections must have been made between the PCP, the personal computer, the motor control center, and all field devices. In addition, wiring must have been checked for continuity and short circuits. Adjust set point values, timing values, and program logic as required to provide a functional hydrant fuel control system. Once the system has been fine tuned and passed the system test, the new system default values, must be loaded into the PLC EEPROM and the personal computer screens adjusted to indicate the new values.

b. A step-by-step Testing Plan of the PCP must be submitted. The test must be designed to show that every device (lights, switches, personal computer display screens, alarms, etc.) on the PCP and personal computer is in working order and that the PLC program controls the system per specifications. The test must be performed in conjunction with Section 33 08 53 AVIATION FUEL DISTRIBUTION SYSTEM START-UP. The plan must include a place for the Contractor and government representative to initial each step of the plan after satisfactory completion and acceptance of each step. The complete initialed Record of Test must be certified by the Contractor and then submitted.

3.4.3 Training Plan for Instructing Personnel

a. Upon completion of the system start-up a competent technician regularly employed by the PCP manufacturer must hold a training class 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 must be a minimum of three 8-hour working days. The training must be designed to accommodate 8 operators, 4 maintenance personnel, and 2 programmers. The Contracting Officer must receive written notice a minimum of 14 days prior to the date of the scheduled classes.

b. Furnish a written lesson plan and training schedule for Government approval at least 60 days prior to instructing operating, maintenance and programming personnel. Concurrently submit above to the SME for their input into the review process. Approval of lesson plan will be based on both Government and SME concurrence. This plan must be tailored to suit the requirements of the Government. The training must be divided into three separate classes. Each class must be tailored to a specific group of personnel. The groups are: 1) Operators, those that will use the control system on a day to day basis; 2) Maintenance personnel, those that will perform routine and non-routine maintenance and trouble shooting of the control system; 3) Programmers, those that will make changes to and trouble shoot the PLC and personal computer programs. The training program must provide:

(1) a detailed overview of the control system including the complete step-by-step procedures for start-up, operation and shut-down of the control system.

(2) a general overview of programmable logic controllers

(3) the maintenance of equipment installed

(4) the programming of the PLC and Personal Computer

(5) trouble shooting of the system

c. Complete approved Operation and Maintenance manuals for Specification 33 09 53AVIATION PUMP CONTROL AND ANNUNCIATION SYSTEM (TYPE III) and 26 20 00 INTERIOR DISTRIBUTION SYSTEM (specifically pertaining to the motor control center and its relay ladder diagrams) must be used for instructing operating personnel. Training must include both classroom and hands-on field instruction. The class must be recorded in DVD format.

d. Provide training courses in DVD format covering system overview, operation, maintenance, trouble shooting, and programming. These DVDs must be produced onsite by the Contractor using the supplied Pump Control Panel as the teaching aid, or commercially produced DVDs by the PLC manufacturer or third party who specializes in training on PLC systems. Along with the DVDs, provide workbooks, which follow along with the DVDs.

3.5 PLC CONTROL SYSTEM SEQUENCE OF OPERATION

The following describes general functions of the fueling system components.

3.5.1 Abbreviations

a. SYS-1: components of System #1 including UPS#1, power supplies, CPU-1, I/O-1, and system #1 input and outputs.

b. SYS-2: components of System #2 including UPS#2, power supplies, CPU-2, I/O-2, and system #2 input and outputs.

c. CPU-1: SYS-1 PLC CPU.

d. CPU-2: SYS-2 PLC CPU.

e. I/O-1: SYS-1 PLC input/output modules.

f. I/O-2: SYS-2 PLC input/output modules.

g. PCP: Pump Control Panel.

h. PC: Personal Computer.

i. UPS: Uninterruptible Power Supply.

3.5.2 Operating Tanks

3.5.2.1 Level Control

Each operating tank has four level float switches to measure low-low, low, high and high-high levels. The switches are DPDT for the redundancy and each pole must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing.

3.5.2.1.1 Low-Low Level

When the low-low level float is activated, the associated tank's graphic display low-low level light illuminates. The following must occur if the tank's outlet valve is not fully closed: activate the low-low level critical alarm sequence, fueling pumps are disabled in automatic mode and pumps are not allowed to start automatically. If all tanks are at low-low level, no fueling pumps shall start automatically.

3.5.2.1.2 Low Level

When the low level float is activated the associated tank's graphic display low level light illuminates and the alarm annunciator's non-critical low level alarm sequence activates.

3.5.2.1.3 High Level

When the high level float is activated the associated tank's graphic display high level light illuminates and the alarm annunciator's non-critical high level alarm sequence activates.

3.5.2.1.4 High-High Level

When the high-high level float is activated the associated tank's graphic display high-high level light illuminates, the alarm annunciator's critical high-high level alarm sequence activates, fueling pumps running in automatic mode must be disabled and no pump must be allowed to start automatically.

3.5.2.2 Level Control

****
NOTE: Use this and the following paragraphs if electronic level switches rather than float switches are used for determinig tank level alarms
****

Each operating tank has level switches to monitor low-low, low, high, and high-high fuel levels. The switches must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. The following alarms must be reported.

3.5.2.2.1 Low-Low Level

When the low-low level elevation is attained the associated tank's GDP low-low level light illuminates. The following must occur if the tank's outlet valve is not fully closed: activate the low-low level critical alarm sequence, fueling pumps are disabled in automatic mode and pumps are not allowed to start automatically. If all tanks are at low-low level, no fueling pumps shall start automatically.

3.5.2.2.2 Low Level

When the low level elevation is attained the associated tank's GDP low level light illuminates and the alarm annunciator's non-critical low level alarm sequence activates.

3.5.2.2.3 High Level

When the high level elevation is attained the associated tank's GDP high level light illuminates and the alarm annunciator's non-critical high level alarm sequence activates.

3.5.2.2.4 High-High Level

When the high-high level elevation is attained the associated tank's GDP high-high level light illuminates, the alarm annunciator's critical high-high level alarm sequence activates, fueling pumps running in automatic mode must be disabled and no pump must be allowed to start automatically.

3.5.2.3 Outlet Valve

Each operating tank's outlet valve has two limit switches to indicate valve position. The closed limit switch is DPDT for redundancy and each pole must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. The closed limit switch must close when the valve is fully closed. When the closed limit switch is closed the associated tank's valve graphic display closed light must activate. When the valve is fully open, the open limit switch is closed. At this time the associated tank's valve graphic display open light must activate.

3.5.3 Product Recovery Tank

3.5.3.1 Fuel Transfer Pump (FTP)

The pump's motor controller has a status relay to indicate the on/off status of the pump. The status relay must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When status relay is open the pump's graphic display off light must activate. When the status relay is closed the pump's graphic display on light illuminates. The status relay state must also be used to start and stop the pumps elapsed run time timer.

3.5.3.2 Overfill Valve (OV)

****

NOTE: The automatic starting and stopping of the fuel transfer pump is accomplished by the actuation of tank float switches connected to the control circuit in the motor control center. The PLC system does not control the starting and stopping.

****

The tank's overfill valve has a limit switch to indicate valve position. The switch is SPST and must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. The switch must close when the valve is fully closed. When the limit switch is closed, the tank's graphic display valve closed light illuminates and the alarm annunciator's critical alarm sequence activates. When the limit switch is open the tank's graphic display valve open light illuminates.

3.5.3.3 High Level Alarm

The tank has a high level alarm float switch. The switch is SPST and must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When the high level alarm float is activated the tank's graphic display high level light illuminates and the alarm annunciator's non-critical alarm sequence activates.

3.5.3.4 High-High Level Alarm

The tank has a high-high level alarm float switch. The switch is SPST and must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When the high-high level alarm float is activated the tank's graphic display high-high level light illuminates, the alarm annunciator's critical alarm sequence activates, fueling pumps running in automatic mode must be disabled and no pump must be allowed to start automatically..

3.5.3.5 Leak Detection

The tank has a leak detection system. The leak detection systems alarm relay must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When the leak alarm is activated the alarm annunciator's non-critical alarm sequence activates.

3.5.4 Fueling Pumps (FP)

There are five fueling pumps with a maximum of four pumps running at one time. The lead pump selector switch must select the pump starting sequence. Each pump's motor controller has a status relay to indicate the on/off status of the pump. The status relay must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When status relay is open the associated pump's graphic display off light must activate and screen number 2 must indicate on. When the status relay is closed the associated pump's graphic display on light must activate and screen number 2 must indicate off. The status relay state must also be used to start and stop the pumps elapsed run time timer and must be displayed on screen number 2.

3.5.5 Jockey Pump (JP)

There is one jockey pump. The jockey pump must not run concurrently with any of the fueling pumps. The jockey pump's motor controller has a status relay to indicate the on/off status of the pump. The status relay must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When status relay is open the associated pump's graphic display off light must activate and screen number 2 must indicate on. When the status relay is closed the associated pump's graphic display on light must activate and screen number 2 must indicate off. The status relay state must also be used to start and stop the elapsed run time timer and must be displayed on screen number 2.

3.5.6 Pumphouse Drain Pump (PDP)

There is one return pump. The return pump's motor controller (ON-OFF switch) has a status contact to indicate the on/off status of the pump. The status contact must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When status contact is open the associated pump's graphic display off light must illuminate and screen number 2 must indicate on. When the status contact is closed, the associated pump's graphic display on light must illuminate and screen number 2 must indicate off.

3.5.7 Flow Switch, FP

On the discharge side of each pump is a flow switch to indicate positive flow (fail safe feature). The flow switch is DPDT for redundancy and each pole must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. If the PLC has given a signal to start a pump and the flow switch has not closed before the set point timer expires or if the flow switch opens after the pump has been running then the pump must be in a failure state and it must be disabled (taken out of the starting sequence), the alarm annunciator's non-critical alarm sequence must also be activated, and the next pump in the start sequence started. After the PLC has stopped all of the pumps, any failed pump must be added back into the start sequence.

3.5.8 Flow Switch, JP

On the discharge side of the jockey pump is a flow switch to indicate positive flow (fail safe feature). The flow switch is DPDT for redundancy and each pole must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. If the PLC has given a signal to start the jockey pump and the flow switch has not closed before the set point timer expires or if the flow switch opens after the pump has been running then the pump will be in a failure state so it must be disabled. The alarm annunciator's non-critical alarm sequence must also be activated.

3.5.9 Flow Switch, PDP

On the discharge side of the PDP is a flow switch to indicate positive flow (fail safe feature). The flow switch is DPDT for redundancy and each pole must be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing.

3.5.10 Transmitters

3.5.10.1 Pressure Indicating Transmitter (PIT)

The PIT's measure system pressure in kPa psi. There are two PITs connected to the PCP for redundancy. PIT-1 and PIT-2 are connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. The system pressure is sent to personal computer display. PIT-3 is connected directly to the Tightness Test Panel.

3.5.10.2 Differential Pressure Transmitter (DPT)

The DPT's measure flow in L/s gpm. There are two issue DPTs (DPT-1 and DPT-2) and two return DPTs (DPT-3 and DPT-4) for redundancy. The DPTs are connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. The net flow is sent to the personal computer display. The issue rate, return rate and net flow must be displayed on the personal computer.

3.5.10.3 Pressure Sensors (PS)

The PS's measure system pressure in kPa psi. There are three PSs installed on the system and there are PCP preparations made for a fourth PS to be temporarily wired in from a Hydrant Pit. PS-1, PS-2, PS-3, and PS-4 are connected to SYS-1 only as indicated on the Terminal Block Connection drawing. These sensors will report various system pressures to the personal computer to be used for the creation of the system graphs as required for screen 7 and described in Section 33 08 53 AVIATION FUEL DISTRIBUTION SYSTEM START-UP.

3.5.11 Control Valves

3.5.11.1 Defuel/Flush Valve (D/FV)

The D/FV must be connected to I/O-1, I/O-2 and UPS#3 as indicated on the Terminal Block Connection drawing. The graphical display open and closed lights and screen number 2 status must activate based on the PLC's output status for the valve. The valve status must be based on the table listed below.

Defuel/Flush Valve Operation - Two Solenoids				
Fueling Mode per PCP Selector Switch	Valve Action	Solenoid A	Solenoid B	Graphical Display
Flush Mode	Open	De-energized	Energized	Open
Automatic Mode Pump(s) On	Closed	De-energized	De-energized	Closed
Automatic Mode Pumps Off	Enabled	Energized	De-energized	Closed
Off Mode Pump(s) On	Closed	De-energized	De-energized	Closed
Off Mode Pumps Off	Enabled	Energized	De-energized	Closed
Tightness Test	Closed	De-energized	De-energized	Closed

3.5.11.2 Pressure Control Valve (PCV)

The PCV must be connected to I/O-1, I/O-2 and UPS#3 as indicated on the Terminal Block Connection drawing. The graphical display enabled and closed lights and screen number 2 status must activate based on the PLC's output status for the valve. The valve status must be based on the table listed below.

Pressure Control Valve Operation - Two Solenoids				
Fueling Mode per PCP Selector Switch	Valve Action	Solenoid A	Solenoid B	Graphical Display
Automatic Mode Pumps Off	Enabled	De-energized	De-energized	Enabled
Automatic Mode Pump(s) On	Closed	Energized	De-energized	Closed
Flush Mode Pumps On	Closed	Energized	De-energized	Closed
Flush Mode Pumps Off	Enabled	De-energized	De-energized	Closed
Off Mode Pump(s) On	Closed	Energized	De-energized	Closed
Off Mode Pumps Off	Enabled	De-energized	De-energized	Enabled
Tight. Test-Hi Pres	Closed	Energized	De-energized	Closed
Tight. Test-Static	Enabled	De-energized	De-energized	Enabled
Tight. Test-Low Pres	Enabled	Energized	Energized	Enabled

3.5.11.3 Backpressure Control Valve (BPCV)

The BPCV must be connected to I/O-1, I/O-2 and UPS#3 as indicated on the Terminal Block Connection drawing. The graphical display enabled and closed lights and screen number 2 status must activate based on the PLC's output status for the valve. The valve status must be based on the table listed below.

Backpressure Control Valve Operation - Two Solenoids				
Fueling Mode per PCP Selector Switch	Valve Action	Solenoid A	Solenoid B	Graphical Display
Automatic Mode Pump Start-Up	Enabled	Energized	De-energized	Enabled
Automatic Mode Prior to Lead Pump Shutoff	Closed	De-energized	De-energized	Closed
Flush Mode	Closed	De-energized	De-energized	Closed
Off Mode Pump(s) On	Enabled	Energized	De-energized	Enabled
Off Mode Pumps Off	Closed	De-energized	De-energized	Closed
Tight. Test-Hi Pres	Enabled	De-energized	Energized	Enabled
Tight. Test-Low Pres	Closed	De-energized	De-energized	Closed

3.5.12 Safety Circuit

3.5.12.1 Emergency Stop Status

The emergency stop circuit status relay (ER1) N.O. contact must be connected to I/O-1, I/O-2 and UPS#3 as indicated on the Terminal Block Connection drawing. When the circuit is activated the alarm annunciator's critical alarm sequence is activated and any calls to start fueling pumps must be canceled and no additional pump start signals must be sent until the circuit has been reset. The fueling pumps will actually be stopped by a emergency stop circuit status relay (ER2) N.O. contact in the fuel pump motor control circuit located in the motor control center.

3.5.12.2 Emergency Shutoff Valves (ESO) Status

The ESO status relay (ER2) N.O. contact must be connected to I/O-1, I/O-2 and UPS#3 as indicated on the Terminal Block Connection drawing. When the relay is closed the GDP valve open lights illuminates. When the relay is open the GDP valve closed lights must activate.

3.5.12.3 Circuit Power Status

The safety circuit power status relay (ER3) N.O. contact must be connected to I/O-1, I/O-2 and UPS#3 as indicated on the Terminal Block Connection drawing. When the relay is closed the PCP emergency circuit power on light illuminates.

3.5.13 Pump Control Panel

3.5.13.1 CPU Faults

The PCP mounted CPU-1 and CPU-2 on lights are connected to both SYS-1 and SYS-2. The associated CPU light must light when no system faults are detected. When a fault is detected by the CPU or it's redundant CPU the faulted CPU's on light must be turned off and the alarm annunciator's non-critical alarm sequence must be activated.

3.5.13.2 Input Select Switch

The 2-position input select switch must control which inputs (System-1 or System-2) are being used. Each switch position must be connected to both SYS-1 and SYS-2. The OI display must indicate the active system.

3.5.13.3 Mode Select Switch

The 4-position switch selects what mode of fueling is active: automatic, flush, Tightness Test or off. Each switch position must be connected to both SYS-1 and SYS-2. The screen number 2 status must indicate the active mode.

3.5.13.4 Lead Pump Selector Switch

The 5-position switch selects which pump must be the lead pump. The switch position must fix the starting sequence for all pumps. The sequences must be 1-2-3-4-5, 2-3-4-5-1, 3-4-5-1-2, 4-5-1-2-3, and 5-1-2-3-4. The off sequence must be the reverse of the start sequence, therefore, first on will be last off. A maximum of four pumps will be allowed to run at one time. If a pump fails to start or fails during operation, that pump will be disabled and the next pump in the sequence started. The screen number 2 status display must indicate the lead pump.

3.5.13.5 PCP Temperature Alarm

The alarm thermostat when activated must activate the alarm annunciator's non-critical alarm sequence.

3.6 OPERATING PROGRAM REQUIREMENTS

The control system's logic program must be stored on a EEPROM chip. Default values of operator adjustable parameters must be permanently stored on the chip with the capability of resetting the values in RAM to the values with in the range specified below. The default values can be changed through the use of the personal computer (after the correct password has been entered). After loss of power and battery failure the adjustable settings must revert back to the default values located on the chip. The default values shown here must be reset to the values determined during the system start up and test.

SET POINT DESCRIPTION	SET POINT RANGE	DEFAULT VALUE
Jockey pump starting pressure	345 to 552 kPa50 to 80 psi	448 kPa65 psi
Timer to enable start-up of jockey pump	0 to 120 seconds	15 seconds
System pressure to stop Jockey pump	345 to 552 kPa50 to 80 psi	517 kPa75 psi
Lead pump starting pressure	205 to 1035 kPa30 to 150 psi	415 kPa60 psi
Issue flow to start second pump in sequence	25 to 40 L/s450 to 650 gpm	35 L/s560 gpm

SET POINT DESCRIPTION	SET POINT RANGE	DEFAULT VALUE
Issue flow to start third pump in sequence	65 to 80 L/s1000 to 1300 gpm	73 L/s1160 gpm
Issue flow to start fourth pump in sequence	100 to 120 L/s1600 to 1900 gpm	111 L/s1760 gpm
Return flow to enable next pump in sequence to start	0.5 to 6 L/s10 to 100 gpm	2.5 L/s40 gpm
Return flow to stop fourth, third, and second pump in sequence (lag pump)	30 to 50 L/s500 to 800 gpm	35 L/s560 gpm
Return flow to initiate lead pump shutdown sequence	30 to 50 L/s500 to 800 gpm	35 L/s560 gpm
Timer to enable start-up of lead pump	0 to 120 seconds	0 seconds
Timer to enable second, third, and fourth pumps to start	0 to 120 seconds	10 seconds
Timer to stop fourth, third, and second pumps	0 to 120 seconds	15 seconds
Timer to stop first pump	0 to 60 seconds	2 seconds
Timer to de-energize (close) Back Pressure Control Valve	0 to 360 seconds	300 seconds
Timer to establish fueling pump failure	5 to 30 seconds	15 seconds
System pressure to stop lead pump	895 to 1310 kPa130 to 190 psig	965 kPa140 psig
Should the operator enter a value not within the range for that parameter, the personal computer must indicate "INVALID ENTRY" and revert back to the previous value.		
A number inside braces, {x}, in the following paragraphs indicates that the number may be changed by the operator via the operator interface within the Set Point Range listed above.		

3.7 AUTOMATIC MODE - IDLE CONDITION (GOOD JOCKEY PUMP)

The fueling system is intended to remain continuously pressurized while in the idle condition. This allows the system to respond immediately to aircraft refueling and defueling requirements. Periodically, in the idle condition, the system will lose minimal pressure. When this occurs, the control system will automatically repressurize in the following sequence:

a. The jockey pump will be commanded to start when the system pressure is less than {448} kPa {65} psig continuously for {5} seconds. If the pressure then rises above {448} kPa {65} psig before the timer

expires, the timer must reset.

b. After the timer expires:

(1) The jockey pump will be commanded start.

(2) All valve positions will remain in the state they were in prior to jockey pump start.

c. With the jockey pump running, 0.31 L/s 5 gpm will flow through the issue venturi. The system pressure upstream of the BPCV will gradually increase {517} kPa {75} psig. When the pressure reaches {517} kPa {75} psig the jockey pump will stop.

d. The conditions exist for a fueling pump to be called to start, the jockey pump will not start or continue to run.

e. When the jockey pump is called to start, a 15 second timer must start. If the timer expires before the flow switch closes the pump must be called off, the alarm annunciator's associated non-critical alarm sequence must activate.

f. If the jockey pump's flow switch opens after the pump has successfully started the pump must be called off, the alarm annunciator's associated non-critical alarm sequence must activate.

3.8 AUTOMATIC MODE - IDLE CONDITION (FAILED JOCKEY PUMP)

The fueling system is intended to remain continuously pressurized while in the idle condition. This allows the system to respond immediately to aircraft refueling and defueling requirements. Periodically, in the idle condition, the system will lose minimal pressure. When this occurs, the control system will automatically repressurize in the following sequence:

a. The lead pump will start when the system pressure is less than {414} kPa {60} psig continuously for {0} seconds. If the pressure then rises above {414} kPa {60} psig before the timer expires, the timer must reset.

b. After the timer expires:

(1) The BPCV solenoid 'A' must be energized to enable the valve to modulate the system pressure at it's set point.

(2) The PCV solenoid 'A' must be energized to close the valve.

(3) The D/FV solenoid 'A' must be de-energized so the valve is closed and solenoid 'B' must be de-energized.

c. With the lead pump running, 45 L/s 600 gpm will flow through the issue venturi. The system pressure upstream of the BPCV will increase to the BPCV set point of 896 kPa 130 psig. 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.

d. With the lead pump running and no fueling demand the return venturi flow rate will equal the issue venturi flow rate. When the return venturi flow rate is greater than {42} L/s {560} gpm a {300} second

timer must start. If the flow rate drops below {42} L/s {560} gpm before the timer expires, the timer must reset, and no changes must be made to the pump and valve status.

e. After the timer expires:

(1) The BPCV solenoid 'A' must be de-energized to close the valve.

(2) The PCV solenoid 'A' must be de-energized to bleed system pressure to 517 kPa 75 psig.

(3) When system pressure rises to 965 kPa 140 psig a {2} second timer must start. After the timer has expired, the lead pump must be stopped.

(4) The Defuel/Flush valve solenoid "A" must be energized 30 seconds after lead pump shut down to allow it to open at 552 kPa 80 psig for defuel operations.

f. The system has now returned to a pressurized and idle condition.

g. When a fueling pump is called to start, a 15 second timer must start. If the timer expires before the flow switch closes the pump must be called off, the alarm annunciator's associated non-critical alarm sequence must activate and the next pump in the sequence must be called to start.

h. If a fueling pump flow switch opens after the pump has successfully started the pump must be called off, the alarm annunciator's associated non-critical alarm sequence must activate and the next pump in the sequence must be called to start.

3.9 AUTOMATIC MODE - REFUELING CONDITION

To start an aircraft fueling operation, an operator connects fueling equipment such as a hydrant hose truck to an aircraft and to a hydrant control valve. When the operator opens the hydrant control valve by use of an hydraulic operated "Deadman", the following sequence occurs:

a. The lead pump will start when PIT-1 or PIT-2 senses a pressure less than {414} kPa {60} psig continuously for {0} seconds. If the pressure then rises above {414} kPa {60} psig before the timer expires, the timer must reset.

b. After the timer expires:

(1) The BPCV solenoid 'A' must be energized to enable the valve to modulate the system pressure at its set point.

(2) The PCV solenoid 'A' must be energized to close the valve.

(3) The D/FV solenoid 'A' must be de-energized so the valve is closed and solenoid 'B' must be de-energized.

c. With the lead pump running, ± 45 L/s 600 gpm will flow through the issue venturi. The system pressure upstream of the BPCV will increase to the BPCV set point of 896 kPa 130 psig. 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.

d. With lead pump running and a issue venturi flow rate greater than {42} L/s {560} gpm and a return venturi flow rate greater than {3} L/s {40} gpm and less than {42} L/s {560} gpm the lead pump will continue to run and the BPCV will modulate to pass flow as necessary to maintain upstream system pressure.

e. With the lead pump running and a issue venturi flow rate greater than {42} L/s {560} gpm and a return venturi flow rate greater than {42} L/s {560} gpm a {300} second timer must start. If issue venturi flow rate falls below {42} L/s {560} gpm or the return venturi flow rate falls below {42} L/s {560} gpm before the timer expires, the timer must reset, and no changes must be made to the pump and valve status.

f. After the timer expires:

(1) The BPCV solenoid 'A' must be de-energized to close the valve.

(2) The PCV solenoid 'A' must be de-energized to bleed system pressure to 517 kPa 75 psig.

(3) When system pressure rises to 965 kPa 140 psig a {2} second timer must start. After the timer has expired, the lead pump must be stopped.

(4) The Defuel/Flush valve solenoid "A" must be energized 30 seconds after lead pump shut-down to allow it to open at 552 kPa 80 psig for defuel operations.

g. With the lead pump running and a issue venturi flow rate greater than {42} L/s {560} gpm and a return venturi flow rate less than {3} L/s {40} gpm a {10} second timer must start. If the issue venturi flow rate falls below {42} L/s {560} gpm or the return venturi flow rate rises above {3} L/s {40} gpm before the timer expires, the timer must reset, and no changes must be made to the pump and valve status.

h. After the timer expires: The second pump must start.

i. With the lead and second pumps running and a issue venturi flow rate greater than {88} L/s {1160} gpm and a return venturi flow rate of greater than {3} L/s {40} gpm and less than {53} L/s {700} gpm the lead and second pumps must continue to run and the BPCV must modulate as necessary to maintain system pressure.

j. With the lead and second pumps running and a issue venturi flow rate greater than {88} L/s {1160} gpm and a return venturi flow rate greater than {53} L/s {700} gpm a (15) second timer must start. If issue venturi flow rate falls below {88} L/s {1160} gpm or the return venturi flow rate falls below {53} L/s {700} gpm before the timer expires, the timer must reset and no changes must be made to the pump and valve status.

k. After the timer expires: The second pump must be stopped.

l. With the lead and second pump running and a issue venturi flow rate greater than {88} L/s {1160} gpm and a return venturi flow rate less than {3} L/s {40} gpm a {10} second timer must start. If the issue venturi flow rate falls below {88} L/s {1160} gpm or the return

venturi flow rate rises above {3} L/s {40} gpm before the timer expires, the timer must reset, and no changes must be made to the pump and valve status.

m. After the timer expires: The third pump must start.

n. With the lead, second and third pumps running and a issue venturi flow rate greater than {133} L/s {1760} gpm and a return venturi flow rate of greater than {3} L/s {40} gpm and less than {53} L/s {700} gpm the lead, second and third pumps must continue to run and the BPCV must modulate as necessary to maintain system pressure.

o. With the lead, second and third pumps running and issue venturi flow rate greater than {133} L/s {1760} gpm and a return venturi flow rate greater than {53} L/s {700} gpm a {15} second timer must start. If the issue venturi flow rate falls below {133} L/s {1760} gpm or the return venturi flow rate falls below {53} L/s {700} gpm before the timer expires, the timer must reset and no changes must be made to the pump and valve status.

p. After the timer expires: The third pump must be stopped.

q. With the lead, second and third pumps running and a issue venturi flow rate greater than {133} L/s {1760} gpm and a return venturi flow rate less than {3} L/s {40} gpm a {10} second timer must start. If the issue venturi flow rate falls below {133} L/s {1760} gpm or the return venturi flow rate rises above {3} L/s {40} gpm before the timer expires, the timer must reset, and no changes must be made to the pump and valve status.

r. After the timer expires: The fourth pump must start.

s. With the lead, second, third and fourth pumps running and a issue venturi flow rate greater than 178 L/s 2360 gpm and a return venturi flow rate of greater than {3} L/s {40} gpm and less than {53} L/s {700>} gpm the lead, second, third and fourth pumps must continue to run and the BPCV must modulate as necessary to maintain system pressure.

t. With the lead, second, third and fourth pumps running and a issue venturi flow rate greater than 179 L/s 2368 gpm and a return venturi flow rate greater than {53} L/s {700} gpm a {15} second timer must start. If the issue venturi flow rate falls below 179 L/s 2360 gpm or the return venturi flow rate falls below {53} L/s {700} gpm before the timer expires, the timer must reset and no changes must be made to the pump and valve status.

u. After the timer expires: The fourth pump must be stopped.

v. When a fueling pump is called to start, a 15 second timer must start. If the timer expires before the flow switch closes the pump must be called off, the alarm annunciator's associated non-critical alarm sequence must activate and the next pump in the sequence must be called to start.

w. If a fueling pumps flow switch opens after the pump successfully started the pump must be called off, the alarm annunciator's associated non-critical alarm sequence must activate and the next pump in the sequence must be called to start.

3.10 AUTOMATIC MODE - DEFUELING CONDITION

To start an aircraft defuel operation, an operator connects a hydrant hose truck to an aircraft and a fuel sense line and an air sense line to the hydrant control valve. The hydrant hose truck has an on-board defuel pump capable of delivering 23 L/s 300 gpm at 1.1 MPa 165 psig. When the operator starts the defuel operation one of the following occurs:

a. If the fueling pumps are running (D/FV closed) the fuel being removed from the aircraft will either go to the other aircraft(s) connected to the system or be returned to the pumphouse where the BPCV will modulate to control system pressure and the fuel will be returned to the operating tanks. The return venturi flow rate will control the number of pumps that are on as discussed in paragraph "AUTOMATIC MODE - FUELING CONDITION".

b. If the fueling pumps are off (D/FV enabled) the fuel being removed from the aircraft will be returned to the pumphouse and both the D/FV and the PCV will modulate to return the fuel to the operating tanks.

3.11 FLUSH MODE

This mode must be used when the system need to be flushed of water or sediment. The operators must first place the manual valve in the desired position to select the appropriate flow path. Placing the selector switch in "flush" the following must occur:

a. The BPCV solenoid 'A' must be de-energized to force it closed.

b. The D/FV solenoid 'A' must be de-energized to allow the valve to open and the D/FV solenoid 'B' must be energized to force it open.

c. Start the fueling pump(s) manually using the Hand-Off-Auto or Hand-Auto switch to obtain the desired flow rate. The automatic pump starts must be disabled in this mode.

d. The PCV solenoid 'A' must be energized when pump(s) are on and de-energized when the pumps are off.

e. When a fueling pump is started, a 15 second timer must start. If the timer expires before the flow switch closes the alarm annunciator's associated non-critical alarm sequence must activate.

f. If a fueling pumps flow switch opens after the pump successfully started the alarm annunciator's associated non-critical alarm sequence must activate.

3.12 TIGHTNESS TEST MODE

This mode must be used in conjunction with the Tightness Monitoring Panel provided by Section 33 52 43.11 AVIATION FUEL MECHANICAL EQUIPMENT to perform tightness tests. Placing the selector switch to "TIGHTNESS TEST" the PCP will send a signal to the Tightness Monitoring Panel telling it that it is ready to perform the tests. At this time it will also operate three MOV valves, closing I25 and I26 and opening I27. The PCP will then receive signals from the Tightness Monitoring Panel to prepare for High Pressure Test, run High Pressure Test, Prepare for Low Pressure Test, run Low Pressure Test, prepare for 2nd High Pressure Test, run 2nd High

Pressure Test, and when the test is over. The following PCP actions will occur after the corresponding signal:

Prepare for High Pressure Test:

a. The BPCV solenoid "A" must be de-energized and the BPCV solenoid "B" must be energized to enable the valve at the 1.1 MPa 160 psi value.

b. The D/FV solenoid "A" must be de-energized and the D/FV solenoid "B" must be de-energized to force it closed.

c. Automatically start the jockey pump to obtain pressure.

d. The PCV solenoid "A" must be Energized and PCV solenoid "B" must be de-energized to close the valve.

e. When the jockey pump is started, a 15 second timer must start. If the timer expires before the flow switch closes the alarm annunciator's associated non-critical alarm sequence must activate.

f. If the jockey pump's flow switch opens after the pump successfully started the alarm annunciator's associated non-critical alarm sequence must activate.

g. If the jockey pump fails to establish flow, automatically start the lead fueling pump to obtain pressure.

h. When a fueling pump is started, a 15 second timer must start. If the timer expires before the flow switch closes the alarm annunciator's associated non-critical alarm sequence must activate.

i. If a fueling pumps flow switch opens after the pump successfully started the alarm annunciator's associated non-critical alarm sequence must activate.

j.MOV I32 will be opened.

k.. The pump will continue to run until such time as the run High Pressure test signal is received. Note: the Tightness Monitoring Panel is monitoring the Loop pressure and when it is satisfied that it is high enough it will instruct the PCP to Run the High Pressure test.

Run High Pressure Test:

a. MOV I32 will be closed.

b. Jockey/Fueling pump will be shut off.

c. The BPCV solenoid "A" must be d-energized and the BPCV solenoid "B" must be de-energized to close valve.

d. The PCV solenoid "A" will be de-energized and the PCV solenoid "B" will be de-energized to enable the valve at the 517 kPa 75 psi value. Note: the Tightness Monitoring Panel will wait for a ten minute settling time to pass, then it will monitor the loop pressure for two minutes. Upon finishing this test it will instruct the PCP to Prepare for the Low Pressure Test.

Prepare for Low Pressure Test:

a. MOV I32 will be opened.

b. The PCV solenoid "A" will be energized and the PCV solenoid "B" will be energized to enable the valve at the 345 kPa 50 psi value.

c. The system will remain in this status until such time as the PCP receives a Run Low Pressure test signal from the Tightness Monitoring Panel. Note: The Tightness Monitoring Panel will monitor the loop pressure until it reaches the 345 kPa 50 psi value. It will then instruct the PCP to run the Low pressure test.

Run Low Pressure Test:

a. MOV I32 will be closed.

b. The system will remain in this status until such time as the PCP receives a Prepare for 2nd High Pressure test signal from the Tightness Monitoring Panel. Note: The Tightness Monitoring Panel will wait for a ten minute settling period to expire, then it will monitor the loop pressure for two minutes. Upon finishing this test it will instruct the PCP to prepare for 2nd High Pressure Test.

Prepare for 2nd High Pressure Test:

a. The BPCV solenoid "A" must be de-energized and the BPCV solenoid "B" must be energized to enable the valve at the 1.1 MPa 160 psi value.

b. The D/FV solenoid "A" must be de-energized and the D/FV solenoid "B" must be de-energized to force it closed.

c. Automatically start the jockey pump to obtain pressure.

d. The PCV solenoid "A" must be de-energized and PCV solenoid "B" must be de-energized to close the valve.

e. When the jockey pump is started, a 15 second timer must start. If the timer expires before the flow switch closes the alarm annunciator's associated non-critical alarm sequence must activate.

f. If the jockey pump's flow switch opens after the pump successfully started the alarm annunciator's associated non-critical alarm sequence must activate.

g. If the jockey pump fails to establish flow, automatically start the lead fueling pump to obtain pressure.

h. When a fueling pump is started, a 15 second timer must start. If the timer expires before the flow switch closes the alarm annunciator's associated non-critical alarm sequence must activate.

i. If a fueling pumps flow switch opens after the pump successfully started the alarm annunciator's associated non-critical alarm sequence must activate.

j. MOV I32 will be opened.

k.pump will continue to run until such time as the run 2nd High Pressure test signal is received. Note: the Tightness Monitoring Panel is

monitoring the Loop pressure and when it is satisfied that it is high enough it will instruct the PCP to Run the 2nd High Pressure test.

Run 2nd High Pressure Test:

a. MOV I32 will be closed.

b. Jockey/Fueling pump will be shut off.

c. The BPCV solenoid "A" must be de-energized and the BPCV solenoid "B" must be de-energized to close valve.

d. The PCV solenoid "A" will be de-energized and the PCV solenoid "B" will be de-energized to enable the valve at the 517 kPa 75 psi value. Note: the Tightness Monitoring Panel will wait for a ten minute settling time to pass, then it will monitor the loop pressure for two minutes. Upon finishing this test it will instruct the PCP that testing is finished.

e. The PCP will leave the system as is until such time as the PCP selector switch is placed into a different mode.

3.13 OFF MODE

a. Automatic starting of fueling and jockey pumps must be disabled. All other functions (GDP, alarm annunciator, personal computer, control valve solenoids, etc.) must be active to allow manual control of the fueling pumps using the Hand-Off-Auto or Hand-Auto switch.

b. When the first fueling pump has been started:

(1) The BPCV solenoid "A" must be energized to enable the valve to modulate the system pressure at it's set point.

(2) The PCV solenoid "A" must be energized to close the valve.

(3) The D/FV solenoid 'A' must be de-energized so the valve is closed and solenoid 'B' must be de-energized.

c. The second, third and fourth fueling pumps maybe started or stopped manually as needed by the operator.

d. After the last fueling pump has been stopped:

(1) The BPCV solenoid "A" must be de-energized.

(2) The PCV solenoid "A" must be de-energized.

(3) The D/FV solenoid 'A' must be energized and D/FV solenoid 'B' must be de-energized.

3.14 MANUAL OPERATION OF FUELING PUMPS

a. If the PLC system is still active see Paragraph "OFF MODE".

b. If the PLC system has no power or both CPUs have faulted (CPU lights on PCP off) the pumping system will be in a completely manual mode. The safety circuit will need power so that the ESO solenoids on the non-surge check valves will be open and fuel can flow. The solenoids

on the other solenoid controlled valves will be de-energized so the valves will have to be manually opened or enabled for the system to run. Other valves may need to be opened or closed manually by the operators for the system to work properly.

3.15 4-VALVE MANIFOLD SUPERVISION

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NOTE: The drawing referenced below is from the DEPARTMENT OF DEFENSE PRESSURIZED HYDRANT FUELING SYSTEM (TYPE III) Standard Drawings. Add the drawing to the design package if applicable.

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a. Prior to initiating fueling operations in the automatic or in the test mode, the 4-valve manifold valves and the two tank outlet valves must be in the proper positions for successful fueling operations. The PLC must monitor valve positions of the 4-valve manifold (sensed by position limit switches for fully opened and fully closed status on valves I34, I35, R10, and R11) and by monitoring valve status on the tank outlet valves (sensed by position limit switches for fully opened and fully closed status on valves I1 and I2). Valve position must conform to the position table listed on drawing M-205 under "Storage Tank Selection".

b. If the system is placed in automatic or tightness test mode, the valve selections must conform to the position table on sheet M-205. If the valve positions do not conform to this table, the PCP will show a 4-Valve manifold error on the alarm annunciator and initiating a critical alarm. The alarm can be silenced, but will not reset until such time as the valve positions do conform to the table.

c. The 4-Valve manifold error critical alarm must be able to be by-passed. A 4-Valve manifold error by-pass 2-position selector switch must be located within the PCP. The 2-position selector switch must be provided with a nameplate "4-Valve Manifold Error". The two positions must be labeled "Enable" and "Bypass". The selector switch when placed in the bypass position must eliminate the critical alarm and allow the system to function. The bypass function must be equipped with a timer that disables the bypass after 12 hours. The timer must reset when the selector switch is returned to the "Enable" position.

-- End of Section --