SAE Aerospace
An SAE International Group

AEROSPACE RECOMMENDED PRACTICE

ARP5918

Issued 2006-07
Reaffirmed 2011-11

Standard Test Criteria for Aircraft Refuelers

RATIONALE

The purpose of this SAE Aerospace Recommended Practice is to establish the minimum recommended test stand setup and to establish the minimum inspection, testing, operation, and performance criteria and procedures to evaluate aircraft refuelers for fueling and/or defueling aircraft.

1. SCOPE

This SAE Aerospace Recommended Practice (ARP) establishes the minimum recommended Test Stand Setup and Procedures for inspecting and testing Aircraft Refuelers. The inspection and test procedure shall be used to evaluate the operation and performance of an Aircraft Refueler to assure that it meets the minimum refueling performance criteria and is fit for aircraft fueling and/or defueling operations. These procedures shall be used to test new Aircraft Refuelers and may be used to perform routine tests to confirm that the Aircraft Refuelers comply with the minimum performance criteria as specified herein.

This document covers all types of Aircraft Refuelers, stationary (e.g., cabinet type units) or mobile (e.g., hydrant service vehicles, tankers, etc).

NOTE: Aircraft refueling vehicle design and operating requirements are provided in separate SAE ARP Documents.

NOTE: This document does NOT address Aircraft Refuelers with operating pressure above 150 psi although many of the paragraphs can be used as a guideline.

2. APPLICABLE DOCUMENTS

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

ARP1247 General Requirements for Aerospace Ground Support Equipment, Motorized and Non-motorized

AIR1375 General Requirements for Aerospace Special Purpose Airline Ground Support Equipment

AIR4783 Glossary of Terms - Aircraft Refueling

AIR4929 Aircraft Refueling Pressure Surge Creation and Limitation

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

ARP4974 Design And Operation of Aircraft Refueling Hydrant Servicers

ARP5818 Design And Operation of Aircraft Refueling Tanker Vehicles

AS5877 Detailed Specification for Aircraft Pressure Refueling Nozzle

SAE Handbook

2.2 API/EI Publications

Available from American Petroleum Institute, 1220 L Street, NW, Washington, DC 20005-4070, Tel: 202-682-8000, http://api-ec.api.org.

API/EI Bulletin 1529 API/EI Standard for Aviation Fueling Hose

API/EI Bulletin 1542 Identification Markings for Dedicated Aviation Fuel Manufacturing and Distribution Facilities, Airport Storage and Mobile Fuelling Equipment

API/EI Bulletin 1581 Specifications and Qualifications Procedures for Aviation Jet Fuel Filter/Separators

API/EI Bulletin 1582 Similarity for API/EI 1581 Aviation Jet Fuel Filter/Separators

API/EI Bulletin 1583 Specifications and Qualifications Procedures for Aviation Jet Fuel Filter Monitors With Absorbent Type Elements

API/EI Bulletin 1584 API/EI Standard for Four-Inch Hydrant System Components and Arrangements

2.3 ASME Publications

Available from American Society of Mechanical Engineers, 22 Law Drive, P.O. Box 2900, Fairfield, NJ 07007-2900, Tel: 973-882-1170, www.asme.org.

ASME B31.3 Process Piping

2.4 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM D 910 Standard Specification for Aviation Gasolines

ASTM D 1655 Standard Specification for Aviation Turbine Fuels

ASTM D 6615 Standard Specification for Jet B Wide-Cut Aviation Turbine Fuels

2.5 ATA Publications

Available from Air Transport Association of America, Inc., 1301 Pennsylvania Avenue, NW, Suite 1100, Washington, DC 20004-1707, Tel: 202-626-4000, www.airlines.org.

ATA Specification 103 Standards for Jet Fuel Quality Control at Airports

2.6 Joint Inspection Group Publications

To be supplied with Purchase Specifications if compliance with this Publication is required.

JIG 9 Guidelines for Aviation Fuel Quality and Operating Procedures for Joint into Plane Fueling Services

2.7 NFPA Publications

Available from the National Fire Protection Agency, 1 Batterymarch Park, Quincy, MA 02169-7471, Tel: 617-770-3000, www.nfpa.org.

NFPA 10 Standard for Portable Fire Extinguishers

NFPA 385 Tank Vehicles for Flammable and Combustible Liquids

NFPA 407 Standards for Aircraft Fuel Servicing

2.8 United States - Code of Federal Regulations (CFR)

Available from the United States Government Printing Office, 732 North Capitol Street, NW, Washington, DC 20401, Tel: 202-512-0000.

Transportation (DOT) 49 CFR 178, 180, 393, 571

2.9 Local Requirements

Available from the local State, Municipality, Governmental Unit, Local Agency, or Airport Owner or Operator's office as required by the Vehicle Purchase Specifications.

3. DEFINITIONS

Definitions for terms or phrases as used in this document are defined in AIR4783, ARP4974, and ARP5818. Other terms or phrases as used in this document shall be defined as follows.

ACCURACY OF A COMPONENT OR SYSTEM: The component or system operate and perform to a level of accuracy as referenced or stated herein.

AIRCRAFT REFUELER OEM: The original equipment manufacturer of the aircraft refueler.

BACK PRESSURE: The pressure gauge reading measured directly downstream of the listed component.

BACK-PRESSURE CONTROL VALVE: The valve on the test stand that is adjusted to produce a pressure reading in the test stand manifold.

CAB-CHASSIS OEM: The original equipment manufacturer of the cab-chassis.

PRIMARY PCS: Primary Pressure Control System, the first pressure control system that controls the aircraft refueling pressure. The PCS may also control flow. All measurements shall be measured directly downstream of the refueling nozzle(s).

PROPER OPERATION: Refers to a component or system as listed and means that the component or system performs in a satisfactory manner as indicated by the manufacturer of component or system. This statement shall also mean that the component, a system, or any integral parts of a system are not damaged, are in good operating condition as required by the component manufacturer's recommended inspection requirements, and that there are no indications showing that any of its parts are faulty.

SECONDARY PCS: Secondary Pressure Control System, the second pressure control system that controls the aircraft refueling pressure directly downstream of the refueling nozzle(s). The PCS may also control flow.

SURGE TEST CONTROL VALVE: The valve on the test stand that is automatically operated to close within a designated timeframe, from full-open to full-closed, to stop fuel flow into the test stand manifold.

VEHICLE OEM: The original equipment manufacturer of the vehicle and identified as the final-stage vehicle manufacturer.

VEHICLE PURCHASE SPECIFICATIONS: The vehicle specifications as stipulated by the purchaser outlining the minimum equipment, capabilities, and operating requirements.

4. TEST FACILITY DESIGN CRITERIA

4.1 General Requirements

The test facility shall be equipped with all necessary test equipment and instrumentation to test aircraft refueling vehicles by simulating aircraft refueling operations and provide a pass or fail result for each particular test. All tests shall be performed to the criteria as described within this document to indicate compliance with this standard. This document provides the minimum test requirements for an aircraft refueling vehicle to document that at the time of testing, the vehicle performs satisfactory for all aircraft refueling operations.

The test facility and its equipment shall be designed to continuously operate without undue stresses or abnormal wear on any components or structures. The test facility shall be designed so that the principles of engineering and ergonomics are designed into the test procedure and functional controls of the test equipment and instrumentation.

All test facilities shall meet all federal, state, local, statutory requirements applicable at the installed location.

4.2 Materials of Construction

All materials in contact with the fuel and not specified elsewhere in this document shall be corrosion resistant and shall not be adversely affected by or affect the fuel. Except for pumps which may be unlined steel, all metallic components and piping shall be of aluminum, stainless steel, or internally lined carbon steel, as required by local code. All material in contact with the fuel shall also be free of cadmium, lead, or zinc. Brass components shall be minimized but accepted in hose couplings and sump drain valves. Copper components will be minimized but accepted in drain lines that render the product as waste fuel. Non-metallic materials shall not affect or be adversely affected by the fuel under any operating conditions specified for any equipment handling the product.

4.3 Refueling System Test Stand Design Requirements

The test stand shall be designed with the minimum components and instrumentation as shown in the attached drawing in Appendix A. The components shall have the following minimum requirements to perform a complete test of an aircraft refueling vehicle:

4.3.1 Fuel Hydrant Discharge System

The fuel hydrant discharge system shall have a piping system with the outlet terminating with a hydrant valve. The fuel hydrant discharge system shall have the following minimum requirements:

4.3.1.1 Comply with ASME B31.3 and NFPA 407 requirements.

4.3.1.2 Pumping system capable of continuously pumping the product at the stable steady Discharge Pressure listed below. The test piping shall be equipped with a pressure control system that maintains a stable fuel pressure within ±2 psig within any period of time during the complete test. The system shall also be capable of continuously pumping at the designated pressure, the minimum flow rate listed below. The Discharge System shall be set to operate as follows:

- Discharge Pressure: 150 psig or the highest steady pressure that is achieved at any hydrant on the airport hydrant system where the vehicle is used (Measured by the hydrant fuel pressure gauge)

- Discharge Flow: Flow rate that is 20% higher than the flow rating of the Aircraft Refueler (as designated by the Aircraft Refueler OEM)

4.3.1.3 Except for airport installations, Filter-Separator and/or filter-monitor vessel(s) that filters all fuel before dispensing it through the hydrant valve.

4.3.1.4 Hydrant valve that meets all API/EI 1584 requirements, unless a different hydrant valve is used on the airport hydrant system where the vehicle is used. The hydrant valve shall have the same components, operation, and performance as the hydrant valves used on the airport hydrant system where the vehicle is used.

4.3.1.5 Hydrant fuel pressure gauge that measures the fuel pressure directly upstream of the hydrant valve. The gauge shall be a digital gauge with a pressure transducer. The gauge shall be calibrated and have a range of 0 to 200 psig and a minimum accuracy of 2% of full scale. The gauge shall also have test ports to calibrate and test its accuracy.

4.3.1.6 Fuel flow meter that measures all fuel dispensed through the test stand. The meter shall be capable of being calibrated to +/-0.1% and 0.05% repeatability and be rated for the operating pressure and flow required for the test vehicle. The meter shall be used as a reference only and not used as a master meter for calibrations.

4.3.1.7 Fuel temperature gauge that measures the fuel temperature directly upstream of the hydrant valve. The gauge shall be a digital gauge and shall have test ports to calibrate and test its accuracy.

4.3.2 Fuel Receiving System

The test stand shall be equipped with a fuel receiving system that returns fuel to a test product tank and does not develop more than 5 psig back pressure measured directly downstream of the underwing nozzle connections. A dedicated test product tank is preferred. The fuel receiving system shall have the following minimum requirements:

4.3.2.1 Ground Fueling System Test

The ground fueling test system shall be used to test the Aircraft Refueler's ground fueling connections. The ground fueling test system shall consist of two 2-1/2 inch underwing nozzle adapters connected to a manifold piping assembly that is symmetrically connected into a tee that connects to a single pipeline that recirculates fuel back to the product tank. The adapters shall be installed so that they are in a horizontal position and at a height of 30 inches ± 10 inches above the ground.

4.3.2.2 Elevated Fueling System Test

The elevated fueling test system shall be used to test the Aircraft Refueler's elevated fueling connections (e.g., connections located on an elevating platform). The elevated fueling system shall consist of two 2-1/2 inch underwing nozzle adapters connected to a manifold piping assembly that is symmetrically connected into a tee that connects to a single pipeline that recirculates fuel back to the product tank. The adapters shall be installed so that they are overhead in a vertical position and at a height of 192 inches ± 1 inch, measured from the ground to the bottom of the nozzle adapter.

NOTE: The test stand may be equipped with either the ground fueling system test setup, the elevated fueling system test setup, or both systems setups as shown in the drawing in Appendix A. As an option, each system test setup for 4.3.2.1 and 4.3.2.2 may be equipped with its own separate test components and instrumentation.

4.3.2.3 Surge Test Control Valve

Two Surge Test Control Valves, one located downstream of each underwing nozzle adapter listed in 4.3.2.1 and/or 4.3.2.2. These valves shall be used to perform the Surge Pressure Limit Test. Each valve shall be of a full-flow ball valve, be actuated to close by an electric motor or air operator system, have a position indication, and have a timer that provide a reading of the closing time when the valve operates from a full open to the full closed position. The valve shall operate as follows:

- Closing Time: 1-1/2 seconds ± 1/2 second full-open to full-closed
- Opening Time: 5 Seconds Maximum

4.3.2.4 Pressure Control Test Valve

Two Pressure Control Test Valves, one located downstream of each Surge Test Control Valve listed in 4.3.2.3. These valves shall be used to perform the Primary and Secondary PCS Operational Tests. Each valve shall be of a butterfly or full-flow ball valve, manually operated. These two valves shall discharge the product into a manifold piping that directs the product into a single pipe and into the Back-Pressure Control Valve listed in 4.3.2.5.

4.3.2.5 Back-Pressure Control Valve

A Back-Pressure Control Valve that is a 4 inch gear operated ball or plug valve installed directly downstream of the Pressure Control Test Valves. This valve shall be used to lock-in a set back-pressure to setup the refueling system components and as a maintenance valve for the Fuel Receiving System. The valve shall be manually operated and a position indicator. (NOTE: Gate valves, while not prohibited, are not recommended because gate is unsupported in any intermediate positions and results in chattering and eventual failure of the valve.)

4.3.2.6 Back Pressure Gauge

Two Back Pressure Gauges that measures the fuel pressure directly upstream of each Surge Test Control Valve listed in 4.3.2.3. The gauge shall be a digital gauge with a pressure transducer. The gauge shall be calibrated, have a minimum range of 0 to 200 psig, and a minimum accuracy of ±2 psig. The gauge shall also have a calibration port to calibrate the gauge and/or check its accuracy.

4.3.3 Test Product Tank

The test stand shall be equipped with a test product tank that receives fuel from the test vehicle. The test product tank shall have the following minimum requirements applicable at the installed location:

4.3.3.1 Comply with ASME B31.3, UL, federal, state, and local requirements. All airport tanks shall be compliant with ATA 103.

4.3.3.2 Have a minimum capacity equal to a volume that allows operating the test vehicle for 15 minutes continuously at the test vehicle's rated flow rate (as designated by the Aircraft Refueler OEM). The system shall operate with a fuel volume and/or equipment that prevents the fuel temperature from exceeding 110 °F.

4.3.3.3 Operate in a manner that limits the static head pressure produced by any quantity of fuel in the product tank to not exceed 2 psig at the nozzle adapters, as measured by the test pressure gauge.

4.3.3.4 Equipped with an automatic low limit shutoff when the fuel level in the product tank reaches a pre-determined low level.

4.3.4 Bottom Loading System

The bottom loading system capable of pumping the product at a maximum pressure of 60 psig ± 5 psig maximum measured at the inlet of the bottom loading connection, and at a minimum flow rate that is 25% higher than the bottom loading flow rating of the test vehicle as designated by the Aircraft Refueler OEM.

4.4 General Operating Requirements

4.4.1 All systems shall be designed to allow quick and efficient testing of the vehicle at any ambient temperature range between -20 and 120 °F, unless a wider range is required.

4.4.2 Except for the size of the piping and components listed in the drawing in Appendix A, all other fueling system piping and components shall be designed to assure that the maximum fuel flow velocity does not exceed the following limits. The maximum fuel flow velocity through components shall be based on the component's nominal size.

a. When Jet Fuel Without SDA (Static Dissipating Additive) is used, the piping and components shall be selected and designed to assure the maximum fuel flow velocity does not exceed 23 feet per second.

b. When Jet Fuel With SDA (Static Dissipating Additive) is used, the piping and components shall be selected and designed to assure the maximum fuel flow velocity does not exceed 31 feet per second.

4.4.3 All hoses that handle fuel shall be designed to assure the maximum fuel flow velocity does not exceed 31 feet per second.

4.4.4 The test system shall provide a minimum relaxation time of 30 seconds from the outlet of the last filter vessel to any discharging outlet or to the return fitting of the test product tank. This includes any vehicle mounted filter(s).

4.4.5 All components and test equipment shall be easily accessible for inspection, testing, operation, and maintenance.

4.4.6 Sampling Points and Fittings

Filter membrane sampling points shall be provided at the following minimum locations:

a. Inlet to the Filter Separator

b. Discharge from the Filter Separator

4.4.7 Sampling fittings shall be equipped with the following minimum components:

a. Probe: Shall be 1/4 inch nominal size and be made of aluminum or stainless steel. The probe shall penetrate through a pipe coupling.

b. Quick Disconnect Coupler.

c. Coupler Dust Cover: Shall be retained to the coupler by a chain or cable.

d. Shutoff Valve: Shall be a stainless steel ball valve. The valve packing shall be Teflon or nylon, but no graphite or similar material.

4.4.8 Filter vessel sump shall be equipped with appropriate fittings, sump lines, and a spring-closed full flow ball valve for water removal.

4.4.9 Hoses

All fueling hoses shall be in compliance with API/EI 1529. The fueling hoses shall have the following minimum requirements:

a. Fueling Hoses: Shall meet all requirements of API 1529 for Grade 2, Type C.

b. Fueling Hose Couplings: Shall meet all requirements of API 1529 (Section 7, Hose Coupling)

All hoses that handle fuel shall have a Testing and Certification Document in compliance with API/EI 1529 and NFPA 407.

4.4.10 Static Grounding and Bonding

All components and equipment on the test stand shall be grounded to a common ground.

4.4.11 A test stand bonding stud shall be provided to allow bonding the test vehicle to the test stand's common ground connection using the vehicle's grounding reel. The resistance between test stand grounding stud and the test stand's common ground connection shall not exceed 25 ohms.

4.4.12 Platforms, Ladders and Handrails

4.4.12.1 Platforms

All platforms shall meet the requirements of 29 CFR 2910.67, OSHA, ANSI applicable standards and any other requirements set forth by the regulatory agency having jurisdiction.

The platform shall have the size and height to provide the necessary working area and configuration to simulate aircraft refueling operations.

4.4.12.2 Handrails

Handrails shall be provided on any fixed-height platform in accordance with OSHA requirements.

4.4.12.3 Toe Board

The platform shall have a toe board around its perimeter, except for any access points. The toe board shall be a nominal 4 inches above the deck floor.

4.4.12.4 Ladders

The ladder shall be designed to be in full compliance with ANSI and OSHA requirements and be designed for a minimum of a 450 pound vertical load. The ladder shall have the following minimum requirements:

a. Step Width: 18 inches.

b. Step Distance: 11 inches.

c. Step Depth: 4 inches.

d. Step Surface: Non-slip under all weather conditions.

e. Toe Clearance: Minimum 6 inches from inner edge of ladder step.

f. Handrails: Minimum 1 inch in diameter.

4.4.12.5 Factor of Safety

All structural members including attachment of major components shall be designed in accordance with safety factors of four unless otherwise specified.

4.4.13 Hydrant System Emergency Shutdown

Emergency shut-off controls shall be installed in the test stand area near the operator's controls and in a conspicuous location and labeled in accordance with NFPA 407.

4.4.14 Electrical System

All electrical equipment, components, and wiring shall meet all the requirements as specified in NFPA 407 and in accordance with NFPA 70 NEC Codes and the requirements set forth by the regulatory agency having jurisdiction.

4.4.15 Lighting

Work area lighting shall be provided to sufficiently illuminate the complete test stand area and the complete area around the vehicle for the operator to perform testing at night. All lights should be designed to minimize glare.

4.4.16 Fire Extinguishers

The test stand shall be equipped with two fire extinguishers having a rating of 20BC, one on each side of the Aircraft Refueler and readily accessible.

The fire extinguishers shall be in compliance with NFPA 10, Standard for Portable Fire Extinguishers and shall comply with local codes.

4.4.17 Spill Kit

The test stand shall be equipped with a spill kit in a readily accessible location in the test area.

4.4.18 Identifications and Markings

4.4.18.1 Operator's Controls

All gauges and controls shall be properly labeled with either engraved plastic or anodized aluminum plates with a minimum of 3/8 inch letters and must be permanently attached. Printed labels shall not be used.

4.4.18.2 Equipment and System Labeling

The fuel system main supply and return lines, direction of flow, and all service points shall be properly labeled in accordance with API Standard 1542 and include and not limited to the following:

a. All test valves

b. The filtration system, product tank sump, and all other draining points.

c. The filter-separator inlet and outlet Sample Points.

d. The test stand Emergency Shut-Off.

e. The test stand bonding connection.

4.4.19 Test Stand Flow Schematic

A schematic showing a line flow diagram of the test stand shall be permanently installed in a readily visible location near the test stand control panel. The schematic shall show all major components, component adjustment settings, and flow rate capabilities. The schematic shall be made either an engraved plastic or anodized aluminum plate and clearly show all components.

5. TEST QUALITY CONTROL

The test personnel shall be responsible to demonstrate compliance with these requirements. The test personnel shall be responsible for assuring accurate documentation for the required tests, certifications, and for the accurate operation of all test equipment required for testing. A copy of the documentation for the calibration or certificates of each test stand equipment component shall be kept in a booklet in the testing area.

The test personnel shall have a test plan covering all tests required by these requirements and all others as referenced by these requirements or recommended by the Vehicle OEM customized for each type of vehicle tested. All such tests shall be performed and documented in a vehicle test booklet and kept on the premises where the vehicle performs the fueling operations.

The jet fuel used in the test stand shall be in full compliance with the latest specifications for the fuel as dispensed by the vehicle.

6. PERIODIC INSPECTION OF TEST STAND OPERATION

The test stand shall be inspected monthly for the operation of all components, systems, valves, gauges, instrumentation, and indicators. All instrumentation shall be calibrated and documented quarterly.

7. AIRCRAFT REFUELER ACCEPTANCE TEST CRITERIA

The test stand components and instrumentation shall be fully operational as required by this document and the Aircraft Refueler shall be acceptable and fit to perform aircraft refueling operations after being tested and passing all tests performed in accordance to the minimum test requirements listed herein. Vehicles shall pass all other tests that are applicable for the equipment or systems as incorporated in the vehicle and as required by the Aircraft Refueler OEM, Vehicle OEM, Cab-Chassis OEM or as required by the Vehicle Purchase Specifications.

7.1 Vehicle Engine and Transmission Shift Interlock

TABLE 1

Test	Performance Requirements
1. Transmission Interlock Operation:	A. Transmission shall only shift through the neutral position when the service brake pedal is depressed sufficiently to assure that the vehicle is stopped.
2. Engine Throttle Interlock Operation:	A. The engine foot throttle in cab shall be deactivated whenever the underwing refueling, overwing refueling, or defueling system is activated.

7.2 Pumping System

TABLE 2

Test	Performance Requirements
1. Road/Pump (PTO):	A. Road/Pump switch shall be operational only when the transmission is in the neutral position and the parking brake or service brakes are applied. B. Proper operation of engine (e.g., pedal is deactivated). C. Proper operation of PTO. D. Proper operation of pump. E. Proper operation of product tank vent.
2. Vehicle Engine and Transmission:	A. Engine accelerates to proper speed as established by the Vehicle OEM, and measured by engine tachometer. B. Transmission shall be in lock-up in the proper gear as established by the Vehicle OEM, and verified by measuring driveshaft speed when pumping.

7.3 Electrical System

TABLE 3

Test	Performance Requirements
1. Battery Master Power Switch:	A. Proper operation of switch.
2. Hose & Cable Reels	A. Proper operation of reels. B. Continuity check between clamp/plug and frame. C. Resistance between chassis frame and each end of bond connection shall not exceed 25 ohms.
3. Lights	A. Proper operation of lights: • All illumination devices • Control Panel Light(s) • Meter Light(s) • Area Work Light(s)
4. Other	A. All system alarms

7.4 System Indicators

TABLE 4

Test	Performance Requirements
1. System Indicators:	A. Proper operation of Road/Pump (PTO) indicator. B. Proper operation of Bottom Load indicator. C. Proper operation of Interlock System Activated indicator. D. Proper operation of Interlock System Override indicator. E. Proper operation of Water Sump Control indicator (Normally “On” and “OFF” when the system is activated). F. Proper operation of Primary PCS indicator. G. Proper operation of Secondary PCS indicator. H. Proper operation of Defuel indicator. I. Optional: Proper operation of Platform Raised indicator. J. Optional: Proper operation of Hydrant Coupler/Nozzles Stowed/Unstowed indicator. K. Optional: Proper operation of Overwing Nozzle Stowed/Unstowed indicator.

7.5 Air System

TABLE 5

Test	Performance Requirements
1. Air Compressor and Air System:	A. Compressor cut-in pressure shall be between 100 and 105 psi. B. Compressor cut-out pressure shall be between 115 and 120 psi. C. Proper operation of air system components: • Air dryer • Air lubrication system • Alcohol injector
2. Air System Fill Process:	A. Vehicle's auxiliary air system shall not supply air to the vehicle's primary or secondary air system. B. Vehicle's secondary air system shall not supply air to the vehicle's primary air system. C. Vehicle's secondary air system shall only fill when vehicle's primary air system reaches approximately 85 psi. D. Vehicle's auxiliary air system shall only fill when the vehicle's secondary air system reaches approximately 65 psi.
3. Air System Drain Valves:	A. Proper operation of valves.
4. Air Pressure Loss:	A. Drive Mode: Air pressure loss shall not exceed 5 psig from an initial pressure of 120 psig after 1 hour with engine off, vehicle in park, parking brakes applied, and hydrant coupler and all nozzles in stowed position. B. Refueling Mode: Air pressure loss shall not exceed 5 psig from an initial pressure of 120 psig after 1 hour with engine off, vehicle in park, parking brakes applied, hydrant coupler and all nozzles in unstowed position, and deadman activated.
Notes:	A. Vehicle's Primary Air System: Vehicle equipped with air brakes, the primary system is the complete air system for the vehicle's service brakes. B. Vehicle's Secondary Air System: Vehicle equipped with air brakes, the secondary air system is the complete air system for the vehicle's parking brakes. C. Auxiliary System: The air system that utilized for all other air operated systems or components in the vehicle or the refueling system.

7.6 Bottom Loading System

TABLE 6

Test	Performance Requirements
1. Bottom Load Operation:	A. Product tank vent valve opens when the bottom loading system is activated. B. Product tank internal valve opens when the fuel pressure from the loading rack is applied to the internal valve through the bottom loading connection(s) and the product tank full level pre-check system is deactivated.
2. Bottom Loading Shutdown System (Pre-Check and Normal):	A. Activation of each primary pre-check shutdown system stops the bottom loading operation within a maximum overshoot of 10% (quantity of fuel calculated by taking 10% of the actual flow rate) measured from the time the primary shutdown system is activated until the complete bottom loading operation stops. The test shall be performed at the vehicle's rated bottom loading flow rate and after performing the bottom loading operation for a minimum period of 30 seconds continuously. B. Activation of the primary pre-check shutdown system, stops the bottom loading operation when the fuel level reaches the full tank capacity marker. C. Activation of the secondary pre-check shutdown system stops the loading operation within a maximum overshoot of 10% (quantity of fuel calculated by taking 10% of the actual flow rate) measured when the secondary shutdown system is activated and after bottom loading at the vehicle's rated flow rate for a minimum period of 30 seconds continuously. D. Activation of the secondary shutdown system sensor, stops the loading operation when the fuel level reaches a predetermined tank level above the full tank capacity marker.

7.7 Vehicle Product Tank and Tank Accessories

TABLE 7

Test	Performance Requirements
1. Product Tank:	A. Hydrostatically tested in accordance with 49CFR 178.345, 178.346, 180, and DOT 406.
2. Product Tank Capacity Markers:	A. Tank capacity markers are installed and safety wired at a location as determined by the Vehicle OEM.
3. Product Tank Capacity:	A. With product tank filled to capacity markers, it shall dispense the quantity of fuel that is indicated by Vehicle OEM at rated flow and without limiting product to the pump.
4. Internal Valve:	A. Opens only after Normal vent is open when in fueling mode.
5. Normal Vent Valve	A. Fully opens only when in fueling or defueling mode, or when bottom loading system is activated.
6. Product Low Level Shutdown	A. See 7.8 Table 8 Text 1.B “Refueling/Defueling System Controls Test.”
7. Product High Level Shutdown	A. See Section 9 Table 18 Test 2.C “Aircraft Defueling Test.”
8. Tank Sump Drain Valves	A. All valves automatically shut-off completely when released.
9. Filter Vessel Drain Valves:	A. All valves automatically shut-off completely when released.
10. Product Tank Level Gauge:	A. Proper operation and accuracy of gauge.
11. Refueling System:	A. No leaks from any refueling system component or piping when tested at a minimum hydrostatic pressure of 150 psi.

7.8 Refueling/Defueling System Controls

TABLE 8

Test	Performance Requirements
1. Refueling/ Defueling System Operation:	A. Refueling system shall be ready to operate when the refueling system is set to refueling mode. B. Refueling system shall stop when the product in the tank reaches a predetermined level that prevents any air to be drawn into the refueling system. C. Defueling system shall be ready to operate when the refueling system is set to defueling mode. D. The defueling system shall stop when air is sensed at any point downstream of the meter to prevent any air to be drawn into the refueling system. (NOTE: Air is drawn into the refueling system when the defueling source is either emptied or pumps air out.)
2. Underwing Refueling System Operation:	A. Underwing refueling system shall only be operational by the use of a deadman control. B. Deadman shall only be operational when the system set to refueling mode or defueling mode. C. Deadman shall not be operational when the system is set to refueling mode or defueling mode, and the interlock override system is activated.
3. Overwing Refueling System Operation:	A. Systems equipped with preset meters, overwing refueling system shall only be operational when the overwing nozzle is removed from storage and the system is preset to dispense a predetermined quantity of fuel. B. When the overwing refueling system is activated, the deadman shall not be required to operate the refueling system. C. Preset meters shall stop the refueling operation once a predetermined quantity of fuel is dispensed.

7.9 Refueling System Control Panel Gauges

Each gauge shall be tested in accordance with the gauge manufacturer's recommendations that indicate that the gauge meets the listed performance requirements.

TABLE 9

Test	Performance Requirements
1. Refueling Pressure Gauges:	A. Accuracy of each fueling gauge shall be within ±2% of full scale.
2. Filter-Separator ΔP Gauge & Test Valve	A. Full stroke operation and accuracy of ΔP gauge shall be within ±2 PSID.
3. Monitor ΔP Gauge & Test Valve	A. Full stroke operation and accuracy of ΔP gauge shall be within ±2 PSID.
4. Thermometer	A. Accuracy of gauge shall be within ±2 °F.
5. Air System Gauge	A. Proper operation of gauge.
6. Pump Pressure Gauge	A. Proper operation of gauge.
7. Primary PCS Pressure Gauge	A. Proper operation of gauge.
8. Secondary PCS Pressure Gauge	A. Proper operation of gauge.

7.10 Aircraft Refueling System Hydrostatic

TABLE 10

Test	Performance Requirements
1. Piping System:	A. Refueling system shall not have any leaks when holding a hydrostatic pressure of 150 psig for a minimum time of 20 minutes.
2. Sump Lines:	A. All sump drain lines shall not have any leaks when holding a hydrostatic pressure of 60 psig for a minimum time of 20 minutes.

7.11 Meter

TABLE 11

Test	Performance Requirements
1. Meter Operation:	A. Refueling systems with electronic meters shall only be activated when the meter is activated by initiating a transaction. B. Meter shall be checked for proper operation.
2. Meter Calibration:	A. Meter shall be sealed and be calibrated in compliance with ATA Specification 103 requirements prior to unit being placed in-service.

7.12 Hydrant Excess Flow Shutdown

TABLE 12

Test	Performance Requirements
1. Hydrant Coupler Excess Flow Shutdown Control:	A. The hydrant coupler shall shutdown flow when the refueling flow rate exceeds a flow rate that is 50 gpm higher than the Aircraft Refueler's flow rate as designated by the Aircraft Refueler OEM operating at maximum flow conditions.

8. AIRCRAFT REFUELING PERFORMANCE TEST

The test shall be performed after all components and system are adjusted and set to the setting as required by the Vehicle OEM. No adjustments shall be made when performing the tests as listed herein. If any component or system warrants an adjustment, the complete performance test shall be redone.

8.1 Underwing Aircraft Refueling With Two Refueling Hoses

The test shall be performed operating two underwing refueling hoses in accordance with the normal aircraft refueling operating procedure as established by the Vehicle OEM. When a vehicle is equipped with more than one operating system, the same test shall be performed with two hoses from each operating system (e.g., a vehicle equipped with two underwing refueling hose reels and two underwing refueling hoses on the lift platform, and each set of hoses is operated through the use of separate venturi, the test shall be performed for each set of hoses separately.)

8.2 Primary PCS and Secondary PCS Performance Test Operating at 0 psig Back-Pressure

The system shall be equipped with a control that allows the Primary PCS and the Secondary PCS to be tested individually. The Primary PCS and the Secondary PCS shall be tested separately for each of the following tests:

TABLE 13

Test	Performance Requirements
1. Flow Rate Limit:	A. The refueling flow rate shall not exceed the flow rate as designated by the Vehicle OEM operating at maximum flow conditions.
2. Refueling Stability:	A. Refueling system shall operate in a stable manner after flowing for a minimum period of 15 seconds continuously, and the refueling pressure may fluctuate a maximum of ±2 psig.
3. Surge Pressure Limit:	A. Surge pressure spike shall not exceed 120 psig when the surge test control valve is turned off, from full-open to full-closed, within a 1-1/2 seconds ± 1/2 second timeframe.
4. Deadman Shutdown	A. Each deadman shall be capable of stopping the refueling system within a maximum overshoot of 5% (quantity of fuel calculated by taking 5% of the actual flow rate). This is measured when the refueling operation is stopped by releasing the deadman after the refueling system is flowing at the vehicle's rated flow rate for a minimum period of 15 seconds continuously. Perform this test for each Deadman Device.
5. Emergency Shutdown	A. Each emergency shutdown control shall be capable of stopping the refueling system within a maximum overshoot of 5% (quantity of fuel calculated by taking 5% of the actual flow rate). This is measured when the refueling operation is stopped by activating the emergency shutdown after the refueling system is flowing at the vehicle's rated flow rate for a minimum period of 15 seconds continuously. Perform this test for each Emergency Shutdown Device.
6. Filter-Separator Shutdown	A. Filter-Separator water sump control valve shall be capable of stopping the refueling system within a maximum overshoot of 5% (quantity of fuel calculated by taking 5% of the actual flow rate). This is measured when the refueling operation is stopped by activating the water sump control valve's shutdown test control after the refueling system is flowing at the vehicle's rated flow rate for a minimum period of 15 seconds continuously.

8.3 Primary PCS and Secondary PCS Performance Test Operating At 40 PSIG Back-Pressure

The system shall be equipped with a control that allows the Primary PCS and the Secondary PCS to be tested individually. The Primary PCS and the Secondary PCS shall be tested separately for each of the following tests:

TABLE 14

Test	Performance Requirements
1. Refueling Nozzle Pressure Gauge	A. If the system is equipped with pressure compensation, all refueling nozzle pressure gauges within shall match the reading as indicated by the manifold pressure gauge ±2 psig at 35 to 58 psig. B. Actual pressure at the nozzle shall never exceed that of the nozzle pressure gauge.
2. Refueling Stability:	A. Refueling system shall operate in a stable manner after flowing for a minimum period of 15 seconds continuously, and the refueling pressure as measured by the control panel refueling pressure gauge may fluctuate a maximum of: • ±4 psig at flow rates up to 150 gpm • ±2 psig at flow rates above 150 gpm
3. Surge Pressure Limit	A. Surge pressure spike shall not exceed 120 psig when the surge test control valve is turned off, from full-open to full-closed, within a 1-1/2 seconds ± 1/2 second timeframe.
4. Primary PCS and Secondary PCS Operation	A. Primary PCS shall limit the refueling pressure to 40 psig. B. Primary PCS shall properly limit the refueling pressure to 38 psig ± 2 psig when the Pressure Control Test Valve is cycled from 30 psig to above 40 psig within a 1-second time frame, a minimum of 3 consecutive times, or as specified by local authority. C. Secondary PCS shall limit the refueling pressure to 50 psig. D. Check that Secondary PCS properly limits the refueling pressure to 48 psig ± 2 psig when the Pressure Control Test Valve is cycled from 30 psig to above 50 psig within a 1-second time frame, a minimum of 3 consecutive times, or as specified by local authority.

8.4 Underwing Aircraft Refueling With One Refueling Hose

The test shall be performed operating one underwing refueling hose in accordance with the normal aircraft refueling operating procedure as established by the Vehicle OEM. When a vehicle is equipped with more than one operating system, the same test shall be performed with one hose from each operating system (e.g., a vehicle equipped with one underwing refueling hose reel and one underwing refueling hose on the lift platform, and each hose(s) is operated through the use of a separate venturi, the test shall be performed for each hose separately.)

8.5 Primary PCS and Secondary PCS Performance Test Operating at 0 psig Back-Pressure

The system shall be equipped with a control that allows the Primary PCS and the Secondary PCS to be tested individually. The Primary PCS and the Secondary PCS shall each individually be tested separately for each of the following tests:

TABLE 15

Test	Performance Requirements
1. Flow Rate Limit	A. Refueling flow rate shall not exceed the flow rate as designated by the Vehicle OEM operating at maximum flow conditions.
2. Refueling Stability:	A. Refueling system shall operate in a stable manner after flowing for a minimum period of 15 seconds continuously, and the refueling pressure may fluctuate a maximum of ±2 psig.
3. Surge Pressure Limit	A. Surge pressure spike shall not exceed 120 psig when the surge test control valve is turn off, from full-open to full-closed, within a 1-1/2 seconds ± 1/2 second timeframe.
4. Deadman Shutdown	A. Each deadman shall be capable of stopping the refueling system within a maximum overshoot of 5% (quantity of fuel calculated by taking 5% of the actual flow rate). This is measured when the refueling operation is stopped by releasing the deadman after the refueling system is flowing at the vehicle's rated flow rate for a minimum period of 15 seconds continuously. Perform this test for each Deadman Device.
5. Emergency Shutdown	A. Each emergency shutdown control shall be capable of stopping the refueling system within a maximum overshoot of 5% (quantity of fuel calculated by taking 5% of the actual flow rate) This is measured when the refueling operation is stopped by activating the emergency shutdown after the refueling system is flowing at the vehicle's rated flow rate for a minimum period of 15 seconds continuously. Perform this test for each Emergency Shutdown Device.
6. Filter-Separator Shutdown	A. Filter-Separator water sump control valve shall be capable of stopping the refueling system within a maximum overshoot of 5% (quantity of fuel calculated by taking 5% of the actual flow rate). This is measured when the refueling operation is stopped by activating the water sump control valve's test shutdown control after the refueling system is flowing at the vehicle's rated flow rate for a minimum period of 15 seconds continuously.

8.6 Primary PCS and Secondary PCS Performance Test Operating at 40 psig Back-Pressure

The system shall be equipped with a control that allows the Primary PCS and the Secondary PCS to be tested individually. The Primary PCS and the Secondary PCS shall each individually be tested separately for each of the following tests:

TABLE 16

Test	Performance Requirements
1. Refueling Nozzle Pressure Gauge	A. All refueling nozzle pressure gauges shall match the reading as indicated by the manifold pressure gauge.
2. Refueling Stability:	A. Refueling system shall operate in a stable manner after flowing for a minimum period of 15 seconds continuously, and the refueling pressure as measured by the control panel refueling pressure gauge may fluctuate a maximum of: • ±4 psig at flow rates up to 150 gpm • ±2 psig at flow rates above 150 gpm
3. Surge Pressure Limit	A. Surge pressure spike shall not exceed 120 psig when the surge test control valve is turn off, from full-open to full-closed, within a 1-1/2 seconds ± 1/2 second timeframe.
4. Primary PCS and Secondary PCS Operation	A. Primary PCS shall limit the refueling pressure to 40 psig. B. Primary PCS shall properly control and limit the refueling pressure to not exceed 38 psig ±2 psig when the Pressure Control Test Valve is cycled from 30 psig to above 40 psig within a 1-second time frame, a minimum of 3 consecutive times. C. Secondary PCS shall limit the refueling pressure to 50 psig. D. Check that Secondary PCS properly controls and limits the refueling pressure to not exceed 48 psig ± 2 psig when the Pressure Control Test Valve is cycled from 30 psig to above 50 psig within a 1-second time frame, a minimum of 3 consecutive times.

8.7 Overwing Aircraft Refueling With One Refueling Hose

The test shall be performed operating each overwing refueling hose in accordance with the normal aircraft refueling operating procedure as established by the Vehicle OEM. The system shall be tested as follows:

TABLE 17

Test	Performance Requirements
1. Overwing Refueling System Operation:	A. Deadman control system shall be disabled when the overwing refueling system is enabled. B. Equipment with preset systems, the refueling system shall be enabled only when the system is preset to dispense a predetermined quantity of fuel. The overwing refueling system shall be capable of stopping within a maximum overshoot of ±1 gallon of the predetermined quantity of fuel. C. The overwing fueling nozzle shall not leak when fueling is stopped.
2. Flow Rate Limit:	A. Refueling flow rate shall not exceed the rate as required by the Vehicle OEM operating at maximum flow conditions.
3. Filtration System:	A. Filter-Separator ΔP gauge shall not exceed ATA 103 requirements. B. Monitor ΔP gauge shall not exceed ATA 103 requirements.
4. Filter-Separator Shutdown:	A. Filter-Separator water sump control valve shall be capable of stopping the refueling system within a maximum overshoot of 5% (quantity of fuel calculated by taking 5% of the actual flow rate). This is measured when the refueling operation is stopped by activating the water sump control valve's manually operated shutdown control after the refueling system is flowing at the vehicle's rated flow rate for a minimum period of 15 seconds continuously.
5. Emergency Shutdown:	A. Each emergency shutdown control shall be capable of stopping the refueling system within a maximum overshoot of 5% (quantity of fuel calculated by taking 5% of the actual flow rate) This is measured when the refueling operation is stopped by activating the emergency shutdown after the refueling system is flowing at the vehicle's rated flow rate for a minimum period of 15 seconds continuously. Perform this test for each Emergency Shutdown Device.