AEROSPACE STANDARD

AS5877™ REV. C

Issued 2001-07
Revised 2024-04

Superseding AS5877B

Detailed Specification for Aircraft Pressure Refueling Nozzle

RATIONALE

AS5877C is the result of a Five-Year Review and update of the specification.

1. SCOPE

This SAE Aerospace Standard (AS) prescribes requirements for the various types of nozzles that are used for the refueling and defueling of aircraft fitted with pressure fuel servicing systems. It is to be used as a replacement for MIL-N-5877 and MS29520 and for all commercial applications.

1.1 Classification

The nozzles specified herein shall be classified in accordance with Table 1. Type I nozzles are primarily used by military services; Type II nozzles are primarily used in commercial service.

1.2 Field of Application

This specification is for all nozzles that are utilized either in commercial or military applications where the aircraft system utilizes pressure fuel-servicing systems. The nozzle shall be compatible with and mate with the international/military aircraft adapter fitting in accordance with ISO 45/MS24484.

1.3 Nozzle Configuration

The nozzle shall conform to the design interface envelope of Figure 1 of this document. The inlet configuration outside of the envelope is at the manufacturer's option and may be designed to have an angled, straight, or variable configuration to meet individual requirements. The envelope restrictions are mandatory to assure that aircraft fuel system manufacturers and nozzle manufacturers have a common interface with which to work. This will assure compatibility between the available nozzles and the aircraft refueling system adapters. The nozzle may be configured to include various features and be available in various inlet configurations including, but not necessarily limited to, those shown in Table 2.

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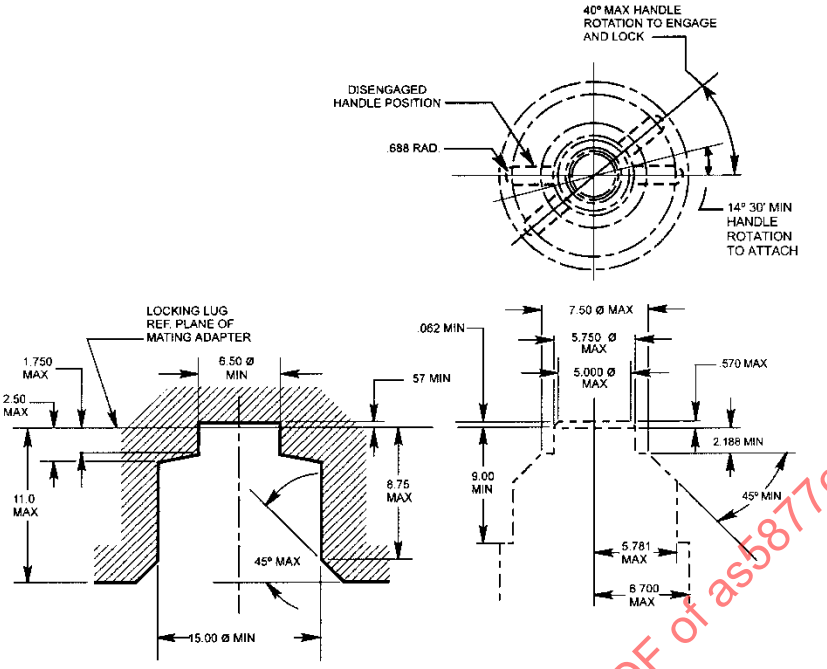
For more information on this standard, visit
https://www.sae.org/standards/content/AS5877C/

Table 1 - Nozzle classifications

Type	Class	Description
I	D-1	Pressure refueling nozzle with a curved inlet with a 6-bolt flange and without a hose end control valve. Various accessories may be added to the basic nozzle as noted herein.
I	D-1R	Same as Type I, Class D-1, except a 45-psi or 55-psi hose end control valve is included as an accessory.
I	D-2	Same as Type I, Class D-1, except the inlet is straight.
I	D-2R	Same as Type I, Class D-2, except a 45-psi or 55-psi hose end control valve is included as an accessory.
I	D-3	Same as Type I, Class D-1, except a variable inlet configuration is used. The variable inlet configuration can assume either the D-1 or D-2 configuration without disassembly.
I	D-3R	Same as Type I, Class D-3, except a 45-psi or 55-psi hose end control valve is included as an accessory.
II	--	Underwing nozzle designed primarily for commercial usage with a straight body and various inlet connections and without a hose end control valve. Various inlets and accessories may be included as noted herein.
II	R	Same as Type II except a hose end control valve is included as an accessory. The customer shall specify the pressure setting for the hose end control valve.
III	--	Underwing nozzle designed primarily for commercial usage with a variable geometry body and various inlet connections, but without a hose end control valve. Various accessories may be included as noted herein.
III	R	Same as Type III except a hose end control valve is included as an accessory. The customer shall specify the pressure setting for the hose end control valve.

Note: Nozzles may be fitted with an optional strainer ball valve.



AIRFRAME ENVELOPE CLEARANCE REQUIREMENTS

NOZZLE MATING DIMENSION ENVELOPE REQUIREMENTS

Notes:

1. Minimum side by side installation dimensions between aircraft adapter installation shall be 10 inches.
2. Dimensions are in inches for clarity. Metric conversions for the dimensions shown above are as follows:

Inches	Millimeters	Inches	Millimeters
.062 min	1.578min	5.750 max	146.05 max
.475	12.07	5.781 max	146.84 max
.506	12.85	6.500 min	165.10 min
.570 max	14.48 max	6.700 max	170.18 max
1.375	34.93	7.500 max	190.50 max
1.438	36.53	8.750 max	222.25 max
1.750 max	44.45 max	9.000 min	228.60 min
2.188 min	55.58 min	11.000 max	279.40 max
2.500 max	63.50 max	15.000 min	381.00 min
5.000 max	127.00 max		

3. Certain provisions (dimensions required for connection with the adapter and envelope dimensions) of this specification are the subject of international standardization agreements NATO STANAG 3105 and ISO 45. When a revision of AS5877 is proposed which shall affect or violate the international agreements concerned, appropriate reconciliation action through international standardization channels shall be taken.

4. Nozzle poppet face shall be located at 0.475 to 0.506 inch above the Adapter Locking Lug Reference Plane (adapter is located in an underwing position with the lugs on the surface away from the aircraft wing). Nozzle poppet travel shall be 1.375 min to 1.436 max inches.

Figure 1 - Envelope requirements

Table 2 - Various features available on nozzles

Feature	Size/Type	Description
Inlet Thread	2 inches, 2-1/2 inches, and 3 inches NPT or BSPP	Inlet configuration may be one of many including, but not limited to, the ones described in this table.
Inlet Flange	2-1/2 inches, 6-through bolt type flange for gasket seal	"Military" type tube connection (formerly MS33786-40) utilized on Type I, Class D-1, D-1R, D-2, D-2R, D-3, and D-3R nozzles for military applications. The inside diameter of the inlet flange shall be 2.506 inches ± 0.009 inch (63.73 mm).
Handle Configuration	Various	Stick, stirrup, and wheel type handles are available from different manufacturers. The manufacturer specifications should be checked before ordering. Note that handle selection may affect nozzle stowage and/or interlock devices on refueling vehicles. Stick type handles are required for military applications.
Strainers	40-mesh 60-mesh 100-mesh	A device, normally mounted in either the inlet disconnect or ball valve, that is designed to be the last defense against and for the detection of "large" contaminants entering the aircraft fuel system. The size of strainer mesh is at the option of the buyer (see 3.3.5 for certain restrictions). Note that the degree of filtration capability is dependent upon mesh and wire size. The manufacturer specifications should be checked before ordering.
Bonding Cable	Varies with manufacturer	An accessory part of the unit as specified in the procurement document. A relatively short cable with either a standard phone type jack plug or an alligator clip (or both) that allows for bonding the nozzle to the aircraft structure. The manufacturer specifications should be checked before ordering. The bonding of the nozzle to the aircraft, although still done in some locations is not a usual requirement. Bonding cables used on underwing nozzles for military applications are limited to Marine Corps/Army equipment only.
Hose End Control Valves (Regulators)	Nominal 2-1/2 inch size with connections to mate the nozzle for which it is designed	Unit designed to limit nominal pressure at the outlet and to sense rapid buildup of pressure in the aircraft manifold and to control surge pressure within the aircraft system. Various pressure settings are available and must be specified in accordance with the manufacturer details. Commonly advertised spring ratings are 35 psig, 45 psig, 50 psig, and 55 psig. Note that the advertised spring ratings may not produce control pressures of the same value. Manufacturer's test reports should specify the actual limits.
Inlet Type - furnished as an accessory of the nozzle	Most will use the sizes and types noted under Inlet Thread	Quick Disconnect - Mates the nozzle to the hose and allow for quick access to a strainer and for quick replacement for repair. A swivel may or may not be present in this type of inlet. Quick Disconnect Dry Break - Same as above except the hose half of the unit is self-sealing or manually sealed to keep the fuel in the hose from draining out of the system when the nozzle is disconnected. Fuel will still be present in the nozzle body and care shall be exercised to keep from spilling this fuel. Strainer Ball Valve or similar type device - A unit incorporating a ball valve or similar type device that allows for the inspection of the strainer without removing the nozzle from the system. Provides for the minimum spillage of fuel from the system. A quick disconnect and/or swivel may or may not be included in this unit.
Swivel	--	This feature may be an integral part of the nozzle or as an added optional feature contained in either the quick disconnect, dry break, ball valve, or similar device. It is needed to ease hose handling during refueling.
Vacuum Breaker	--	An optional accessory part of the unit as specified in the procurement document. A small spring-loaded valve mounted on the side of the nozzle to allow for the incursion of atmospheric pressure to the fuel system to prevent the formation of an excessive vacuum within the system. The manufacturer's specifications should be checked before ordering.

2. REFERENCES

2.1 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.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

ARP5298 Aircraft Fueling Adapter Wear Limits

2.1.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM D910 Standard Specification for Aviation Gasolines

ASTM D1655 Standard Specification for Aviation Turbine Fuels (Jet A and Jet A-1)

ASTM D6227 Standard Specification for Grade 82 Unleaded Aviation Gasoline

ASTM D6615 Standard Specification for Jet B Wide-Cut Aviation Turbine Fuel

2.1.3 U.S. Government Publications

Copies of these documents are available online at https://quicksearch.dla.mil.

MIL-DTL-5624 Turbine Fuel, Aviation, Grades JP-4 and JP-5

MIL-DTL-83133 Turbine Fuel, Aviation, Kerosene Type, Grade JP-8 (NATO F-34), NATO F-35, and JP-8+100 (F-37)

MIL-PRF-7024 Calibrating Fluid, Aircraft Fuel System Components.

MS24484 Adapter, Pressure Fuel Servicing, Nominal 2.5 Inch Diameter

MIL-QPL-5877 Qualified Product List of Products Qualified Under Performance Specification SAE-AS5877 Nozzle, Aircraft Pressure Refueling

FED-STD-H28 Screw Thread Standards for Federal Services

2.1.4 International Publications

2.1.4.1 United Kingdom Ministry of Defence - (UK MOD) Publications

Available from Ministry of Defence - UK, UK Defence Standardization, Kentigern House, Room 1138, 65 Brown Street, Glasgow G2 8EX, UK, https://sts.defencegateway.mod.uk.

MOD DEF STAN 91-091 (DERD 2494) EN-Turbine Fuel, Kerosine Type Jet A-1 NATO Code: F-35; Joint Service Designation AVTUR

2.1.4.2 NATO Publications

Copies of these documents are available online at https://nso.nato.int/nso/nsdd/main/standards.

NATO STANAG 3105 Pressure Refuelling Connections and Defuelling for Aircraft - ED 7

2.1.5 ISO Publications

Copies of these documents are available online at https://webstore.ansi.org/.

ISO 45 Aircraft Pressure Refueling Connections

ISO 68 International Standard - General Purpose Screw Threads, Basic Profile

2.1.6 A4A Publications

Available from Airlines for America (A4A), 1301 Pennsylvania Avenue, NW, Suite 1100, Washington, DC 20004, Tel: 202-626-4000, www.airlines.org.

A4A Specification 103 Standard for Jet Fuel Quality Control at Airports

2.1.7 Energy Institute Publications

Available from EI, 61 New Cavendish Street, London W1G 7AR, UK, Tel: 44 (0) 20 7467 7100, https://www.energyinst.org.

EI 1529 Hose, Aviation Refueling

2.1.8 British Standards Institution (BSI) Publications

Available from 289 Chiswick High Road, London W4 4AL, UK, Tel: 44 845 086 9001, https://www.bsigroup.com.

BS 1580 Specification for Unified Threads. Diameters 1/4 Inch and Larger

2.2 Related Publications

The following publications are provided for information purposes only and are not a required part of this SAE Technical Report.

2.2.1 ISO Publications

Copies of these documents are available online at https://webstore.ansi.org/.

ISO 228/1 Standards for Pipe Threads for Tubes and Fittings

2.2.2 JIG Publications

Copies of these documents are available online at https://www.jig.org/standards-publications/.

JIG 1 Aviation Fuel Quality Control and Operating Standards for Joint Into-Plane Fuelling Services

3. REQUIREMENTS

3.1 Qualification

3.1.1 Nozzles approved to this specification require qualification. Qualification testing shall consist of the tests specified in Section 4 and shall be performed in accordance with the provisions of 5.2.

3.1.2 Nozzles for military applications approved to this specification shall be listed or approved for listing on the qualified products list (QPL) in accordance with the provisions of 5.2. Changes in product formulation raw material, basic methods of manufacturer, or design changes that affect form, fit, or function for qualified nozzle listed or approved for listing on the QPL, without first notifying the responsible QPL agency, may result in the product being disqualified and removed from the QPL.

3.1.3 Nozzles for commercial applications shall be approved in accordance with the particular user requirements on approval of equipment.

3.2 Materials

All materials used in the nozzle shall be chemically compatible with and not adversely affect the nozzle's operation or the quality of the fuel when used with fuels specified in 3.3.15. Magnesium, manganese, copper, zinc, cadmium, or their alloys (alloys containing more than 5% of the subject materials) shall not be used in parts wetted by fuel and subject to wear. Corrosion-resistant metals shall be used. Exterior surfaces susceptible to impact or contact with the airport apron or other surfaces shall be made of aluminum, stainless steel, plastic, or other material that will not cause a spark when contact is made. Unless suitably protected against electrolytic corrosion, dissimilar metals shall not be used in contact with each other. Materials subject to potential corrosion must be suitably coated with a process that will not contain any of the above-restricted materials.

3.3 Design

3.3.1 Envelope and Interface

The nozzle shall interface with ISO 45/MS24484 pressure refueling adapter. The nozzle envelope shall not exceed that specified in Figure 1.

3.3.2 Flow Rate

The nozzle shall allow a flow rate of up to 2271 L/min (600 gpm) with an operating pressure as specified in 3.3.17.1.

NOTE: Some applications (small airports) that require flow rates less than 2271 L/min (600 gpm) may be approved to this specification upon mutual agreement between manufacturer and approving customer. All other requirements, except for the reduced flow rate, shall remain the same.

3.3.3 Operation

The nozzle shall have an operating lever or other suitable means to mechanically open or close the nozzle. The lever is not intended to be utilized for control or shutting off the flow. It is used to open or close the nozzle during no-flow conditions. This operating lever action shall be independent from the action used to attach the nozzle to the aircraft adapter. Operation of the lever will simultaneously open or close the adapter sealing unit, which will allow flow to or from the aircraft, or other vehicle to which the nozzle is attached. Removal of the nozzle from the adapter shall be impossible unless the lever is in the closed, no-flow position. It shall also be impossible to open the nozzle unless it is attached properly to a mating adapter in good repair (wear limits for the adapter are defined in ARP5298). The lever shall remain in either the full flow or no-flow position under the full range of flow rates and pressures, during fueling or defueling, without the need of maintaining a continuous manual holding force.

NOTE: The forces within the nozzle/adapter combination are a function of the internal nozzle design and the design of the adapter as controlled by MS24484.

3.3.4 Interface Seal

The interface seal shall prevent leakage when the nozzle and adapter are connected and open. The seal shall compensate for wear on the adapter (as defined in MS24484 and/or ARP5298), wear on the nozzle, dimensional tolerances, side loading, and temperature changes.

3.3.5 Strainer

All nozzles shall have provisions for the installation of a strainer as an optional feature. Strainers are commonly referred to as being 40-mesh, 60-mesh, or 100-mesh. However, the open flow area through the strainer is determined by the size of wire cloth used. The minimum open area for each size shall be as shown in Table 3.

Table 3

Mesh Designation	Minimum Open Flow Size - Microns
40-mesh	450
60-mesh	300
100-mesh	145

Provisions shall be made in the design to allow quick easy inspection and cleaning of the strainer by a single person with the use only of basic hand tools. The design shall be appropriate to allow routine (e.g., weekly) repeated disassembly/assembly without damage to the nozzle. Any devices designed for removal of the nozzle to check the strainer or to replace the nozzle shall be securely locked by appropriate means to prevent inadvertent disconnect during use or storage. Strainers must be robust enough to withstand 827.4 kPa (120 psi) differential (in the normal flow direction) when fully blocked. The design of the strainer installation shall not impede the use of any other options, such as, but not limited to, quick disconnect dry-breaks, pressure test devices, ball valves, or sampling port devices.

3.3.6 Accessory/Ambient Ports

Provisions for two accessory ports shall be made through the body wall of the nozzle to allow for installation of a pressure gauge, a vacuum breaker, or fuel sampling tap. The ports shall have a 0.375 inch NPT, 12 mm ISO straight pipe thread, or 0.375 inch BSPP thread. Location and configuration shall allow insertion of a sampling probe, which protrudes 14.2 mm (0.56 inch), into the flow path of the nozzle body. The probe shall not interfere with the operation of the nozzle. Unless the nozzles include accessories to be mounted in these ports, they shall be closed with pressure tight plugs. If used (Class D-1R, D-2R, D-3R, and R only), the breather or vent port in the side of the hose end control valve shall be designed to divert any leakage or flow of fuel from it away from the operator of the nozzle during an operation. The breather or vent port, when used, shall have a 7/16-20 UNF-3B thread with O-ring sealing capability (old AND10050-4) to allow for in-field blocking out during the testing of other components in the system.

3.3.7 Inlet Swivel

Each nozzle shall have a swivel capable of 360-degree rotation included as an integral part of the nozzle or as an accessory to the nozzle to ease the connection of the unit to an aircraft or other receiving vehicle. The swivel design shall not inhibit movement while the hose is being subjected to operating pressure.

3.3.8 Handles

The nozzle shall incorporate handles that facilitate carrying and connection to the receiving vehicle. The handles can be of optional configuration, common ones being stick, stirrup, and wheel. The handles shall include material of nonslip characteristics in the areas in which the operator's hands will come in contact. The handles shall be within the envelope specified in Figure 1. Length of the stick type handles is at the option of the manufacturer and or the procuring customer.

3.3.9 Bonding Cable

Provisions for the installation of a bonding cable shall be provided as a customer specified option. The connecting clip/plug and the nozzle body material shall have a maximum electrical resistance of 25 Ω.

3.3.10 Hose End Control Valve (also interchangeably called Hose End Pressure Regulator)

Class D-1R, D-2R, D-3R, and R nozzles shall incorporate this device designed to limit delivery pressure at the outlet and to react to changing aircraft manifold pressures to prevent excessive surge pressures within the manifold. The customer specifies the pressure setting. Most common usage is 45 psig for commercial and U.S. Army; 55 psig for U.S. Navy, U.S. Marine Corps, and U.S. Air Force.

3.3.11 Maintenance

Wherever possible, industry standard seals (packings or O-rings) shall be utilized provided they meet the requirements of this specification. The overhaul of the nozzle shall be possible by maintenance personnel with a minimum of training, tools, and equipment normally available commercially.

3.3.12 Protective Devices

A protective bumper of a fuel-resistant material shall be provided around the outlet major diameter to protect the aircraft structure and the nozzle from accidental impact damage during use and operation. Optional self-sacrificing (of non-foreign object damage [FOD] design), brackets, pads, or rings may be provided to protect certain critical parts of the nozzle from damage caused by dragging.

3.3.13 Dust Cap

A nonmetallic cap shall be provided to prevent dust and other foreign debris from entering the outlet portion of the nozzle during handling and storage. When the nozzle is connected to a receiving adapter, the dust cap shall hang free so that it shall not interfere with the refueling operation. The use of springs for cap retention is not allowed. The material of the cap shall be resistant to exposure to ultraviolet, aviation fuels, and the combination of high humidity and temperature.

3.3.14 Lubrication

The nozzle shall operate without the use of lubricants.

3.3.15 Fuel Compatibility

The nozzle shall not malfunction when used with fuels conforming to MIL-DTL-5624, MIL-DTL-83133, MOD DEF STAN 91-091 (DERD 2494), ASTM D1655, ASTM D6227, ASTM D6615, and ASTM D910.

3.3.16 O-Rings, Packings, and Seals

O-rings or packings and associated seals shall be suitable for use in hydrocarbon fuels and meet the test requirements of this specification. Special shaped seals shall be kept to a minimum.

3.3.17 Pressures

3.3.17.1 System Operating Pressure

The nozzle shall be designed to refuel aircraft at a maximum operating pressure of 413.7 kPa (60 psi) with a surge pressure of up to 2068.5 kPa (300 psi).

3.3.17.2 Pressure Loss

The corrected gauge pressure loss across the nozzle and the mating adapter shown in Figure 4 shall be kept to a minimum. The use of the adapter in Figure 4 provides a standard of comparison for all manufacturers. Other pressure loss data using other mating adapters may also be useful to the customer.

3.3.17.2.1 Military Type I, Class D-1, D-2, or D-3 Nozzles

The pressure loss across the nozzle/adapter combination shall not exceed 103.4 kPa (15 psid) at a flow rate of 2271 L/min (600 gpm).

3.3.17.2.2 Military Type I, Class D-1R, D-2R, or D-3R Nozzles

The pressure loss across the nozzle/hose end control valve/adapter shall not exceed 241.4 kPa (35 psid) at a flow rate of 2271 L/min (600 gpm). The hose end control valve shall be in a full (blocked) open position for this requirement.

3.3.17.2.3 Commercial Nozzles, All Types

Due to the many commercial configurations possible no specific design parameter will be offered in this document for those nozzle configurations. Manufacturers shall determine and report the pressure loss for the various combinations of equipment offered.

3.3.17.3 Pressure Limitation (Class D-1R, D-2R, D-3R, and R Nozzles Only)

Using the test setup specified in 4.6.3, with flow rates from 2271 to 95 L/min (600 to 25 gpm), the regulator shall limit the downstream pressure to a maximum of 34.5 kPa (5 psig) above the nominal spring setting. At flow rates at or near zero (less than 19 L/min [5 gpm]), the pressure shall not exceed 68.9 kPa (10 psig) above the nominal pressure setting.

3.3.17.4 Surge Pressure (Class D-1R, D-2R, D-3R, and R Only)

With 86.3 kPa (12.5 psig) back pressure and inlet pressure from 413.7 to 689.5 kPa (60 to 100 psig), and a downstream valve closure of 0.5 second, the downstream surge pressure shall not exceed 827.4 kPa (120 psig).

3.3.17.5 Proof Pressure

The nozzle when connected to a test adapter and opened shall withstand pressures up to 2068.5 kPa (300 psig). The nozzle when closed shall withstand pressures up to 827.4 kPa (180 psig).

3.3.17.6 Burst Pressure

The nozzle when connected to a test adapter and opened shall withstand pressures up to 3102.8 kPa (450 psig) without structural failure. The nozzle when closed shall withstand pressures up to 1654.8 kPa (240 psig) without structural failure. Seal leakage at this pressure shall not be considered a structural failure.

3.3.18 Operating Lever

The operating lever shall operate from the full closed to full open positions with a maximum applied torque of 46.1 cm kg (40 in-lb) when a force of 222.4 N (50 pounds) is applied against the nozzle poppet in the direction to close the nozzle.

3.3.19 Strength

The nozzle shall withstand the loads shown on Figures 2 and 3 without leakage, distortion, or failure when tested in accordance with 4.6.7.

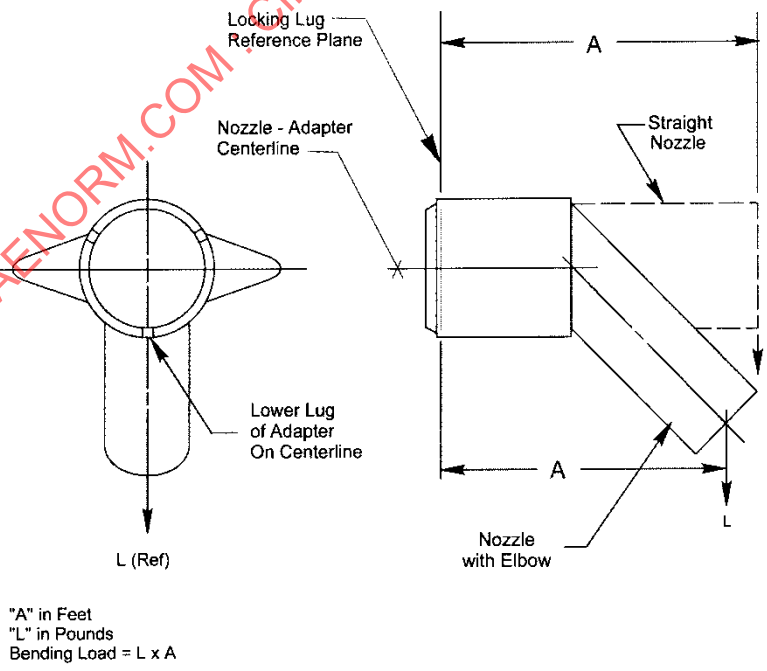


Figure 2 - Strength test setup

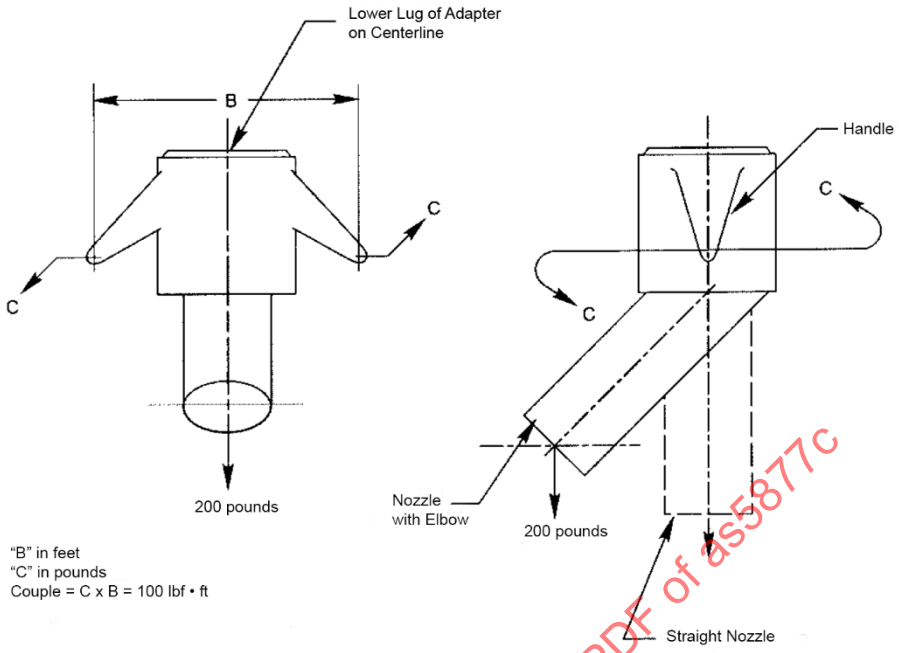


Figure 3 - Swivel strength test setup

3.3.20 Electrical Continuity

Electrical continuity between the nozzle and aircraft adapter shall be established through the attaching lugs when the units are connected. The resistance from the nozzle inlet to the adapter-locking flange shall be no greater than 10 Ω.

3.3.21 Construction

The nozzle and accessories shall withstand the testing program outlined in Section 4. It should be understood that this testing program may not represent the normal daily operational requirements at many locations.

3.3.22 Interchangeability

All parts having the same manufacturer's part number shall be functionally and dimensionally interchangeable with the like part number regardless of the date of manufacture. Changes to detail parts of the nozzle shall be made only after such interchangeability has been proven. Possible requalification may be required if changes are made that affect interchangeability of a part(s) within the nozzle. A new manufacturer's model (part) number for the basic nozzle shall be created to control interchangeability with nozzles in service.

3.3.23 Parts Availability

Interchangeable parts or replacements for the nozzle shall be available for a minimum of 10 years after the last sale of a particular model nozzle.

3.3.24 Weight

The weight of a nozzle shall be kept to a practical minimum consistent with the anticipated required operation.

a. Military Type I Nozzles: The weight of Class D-1, D-2, or D-3 nozzles shall not exceed 5.2 kg (11.5 pounds). The weight of Class D-1R, D-2R, or D-3R nozzles shall not exceed 6.3 kg (14 pounds).

b. Commercial Nozzles: Due to the many commercial configurations possible, no specific design parameter shall be offered in this document for those nozzle configurations.

3.3.25 Threads

All fastener threads shall be in accordance with FED-STD-H28, BS 1580, or ISO 68.

3.3.26 Locking of Threaded Parts

All threaded parts shall be locked to prevent loosening or detachment which would result in the part entering the system being refueled or cause failure to the nozzle. The use of a locking compound shall be kept to a minimum and used only where its use is not necessary in the overhaul or maintenance procedures in the field.

3.3.27 Quality Control System

The manufacturer shall operate under an approved quality control system.

3.3.28 Operational/Maintenance Manual

A manual, which provides specific instructions for the operation, maintenance, and repair requirements with exploded parts illustrations and/or section drawings and parts listing, shall be made available to all customers.

3.3.29 Identification of Product

All nozzles shall be marked with at least the manufacturer's name, model number, and a unique serial number in a location that will not affect performance and will not be subject to destruction during anticipated use.

3.3.30 Failure Modes and Effects Analysis (FMEA)

The manufacturer shall prepare a detailed nozzle FMEA which will at a minimum list each individual component or piece part, its purpose, each possible component failure, and the effect of each failure under operating conditions.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The manufacturer is responsible for the performance of all inspection requirements specified herein. The manufacturer may use their own or any other facilities suitable for the performance of the inspection requirements specified herein.

4.1.1 Responsibility for Compliance

The inspection set forth in this specification shall become a part of the contractor's overall inspection system or quality program. The absence of any inspection requirements in the specification shall not relieve the contractor of the responsibility of assuring that all nozzles comply with all requirements of this specification.

4.2 Classifications of Inspections

The inspection requirements specified herein are classified as follows:

a. Qualification Inspection (see 4.3)

b. Acceptance Testing Inspection (see 4.4)

4.3 Qualification Inspection

Qualification inspection shall consist of the tests specified in 4.3.1 and the field evaluation program outlined in 4.3.2.

4.3.1 Qualification Tests

The qualification tests, which are listed in Table 4, shall be conducted on two sample nozzles, which are production units. The tests shall be conducted in the sequence listed in Table 4.

4.3.1.1 Rejection and Retest

When a nozzle fails to meet any of the requirements of the qualification tests, the program shall be halted until the extent and cause of the failure is determined. A complete disclosure of the failure, the cause and the solution shall be included in the final qualification test report. All qualification tests, which are affected by the corrections, shall be repeated.

4.3.1.2 Test Report

The manufacturer shall provide, upon request from any customer or potential customer, a complete test report reflecting conformance to the testing requirements herein. This report shall be complete and include, as a minimum, an outline of all tests conducted, test conditions, diagrams of all test setups, copies of test data sheets, list and descriptions of testing equipment, any failure, its analysis and corrections, and the final conclusions.

4.3.1.3 Operational/Maintenance Manual

An operational/maintenance manual in accordance with 3.3.28 shall be provided as a part of the qualification package when requesting approval for the nozzle.

4.3.1.4 Maintenance of Qualified Status

The qualification test samples shall be produced using identical manufacturing methods as those utilized or intended to be utilized in the manufacture of the production units. Any subsequent changes to materials, manufacturing processes, or functional dimensions or tolerances thereof to working parts which may degrade or decrease material properties or unit performance shall be supported by appropriate requalification testing.

Table 4 - Qualification testing sequence

Test	Test Sequence		Test Para
	Sample 1	Sample 2	
Examination of Product	1	1	4.6.1
Proof Pressure	2	2	4.6.10
Calibration	--	--	4.6.2
Functional - Static	3	3	4.6.2.1
Pressure Loss	4	4	4.6.2.2 thru 4.6.2.2.2
Regulator Performance (Class D-1R, D-2R, and R only)	5	5	4.6.3
Leakage	6	6	4.6.4
Swivel Endurance	7	--	4.6.6
Endurance	8*	--	4.6.8.1 thru 4.6.8.1.2
Regulator Endurance	9	--	4.6.8.2 thru 4.6.8.2.1
Electrical Conductivity	--	7	4.6.13
Fuel Resistance and Extreme Temperature	--	8	4.6.5
Accelerated Corrosion	--	9	4.6.9
Strength	--	10	4.6.7
Drop Test	--	11	4.6.12
Endurance - Extended Operation	11	--	4.6.8.1.3
Endurance - Extended Regulator	12	--	4.6.8.2.2
Defuel Endurance	13	--	4.6.8.2.3
Worn Adapter Test	14		4.6.16
Burst Pressure	15	--	4.6.11
Disassembly and Inspection	10 and 16*	12	4.6.14
Strainer Strength	Mandatory**	--	4.6.15

* Following the endurance test on sample one, the nozzle shall be disassembled and inspected in accordance with 4.6.14. It shall then be reassembled, and the testing program beginning with 4.6.8.1.3 shall be resumed. Disassembly and inspection shall then follow the burst pressure test as noted in the sequence above.

** An optional defuel flow test may be requested by the customer.

4.3.1.5 Qualification by Similarity

Changes to any detail part that do not affect interchangeability with the part it replaces can be made without changing the model (part) number of the nozzle. If these changes do not affect structural integrity, form, fit, or function, the nozzle qualification status won't be affected. Changes to any detail part, or its next assembly, of the nozzle for any reason that affect interchangeability of the part with the part it replaces will require a new model number for the nozzle. Such changes that require a new model number may be qualified by similarity to previously qualified units provided that the new design is truly similar in design, material, and method of manufacturing. Evidence justifying similarity shall be included in the qualification test report. Where similarity cannot be justified, certain tests, as appropriately caused by the design changes, shall be repeated and a report covering such testing provided to cover the complete qualification of the nozzle. This report shall include all previous testing as well as the specific testing to justify the new design changes and the rationale for a partial qualification program in lieu of a complete requalification.

4.3.2 Field Trial and Approval (Optional)

Following qualification testing and prior to the sale of production units, field trials at a minimum of four locations for a minimum of 6 months shall be conducted. These tests shall be at representative locations where daily use of the equipment is anticipated, i.e., international airports, military bases, or other locations where a minimum of ten refueling operations are conducted daily. The trial locations will also be chosen to subject the nozzles to temperature extremes of -29 to 38 °C (-20 to 100 °F), areas of high humidity and coastal locations where corrosion potential is highest. Testing shall be conducted on nozzles installed on hose reel applications where the most potential damage is anticipated. It is anticipated that such field trials will be a requirement of receiving formal approval of the nozzle from major oil companies and other major international using organizations. Upon completion of the testing program, the nozzles shall be retrieved and a report written by the manufacturer on the results of the tests. This report shall be available to any customer upon request.

NOTE: If field trials are not required by the customer, the customer assumes responsibility for final approval and use.

4.4 Acceptance Inspection

Each nozzle produced shall be subjected to the following tests prior to shipment as shown in Table 5.

Test records shall be maintained by serial number by the manufacturer for a minimum of 12 months following shipment and shall be made available to any customer upon request.

Table 5

Test	Paragraph
Examination of Product	4.6.1
Functional	4.6.2.1
Leakage	4.6.4
Downstream Lockout (Class D-1R, D-2R, D-3R, and R only)	4.6.3.2.5
Proof Pressure	4.6.10

4.5 Test Conditions

Unless otherwise specified, the following test conditions shall apply.

4.5.1 Test Fluid

Odorless kerosene, commercial solvent 140, MIL-PRF-7024 (Type II), or another equivalent test fluid shall be used when a specific fluid is not specified. Water shall not be used for testing purposes.

4.5.2 Ambient Temperature and Pressure

All tests shall be performed with the ambient and test fluid at temperatures of 15.6 to 32.2 °C (60 to 90 °F) and at local barometric pressure.

4.5.3 Test Adapter

The test adapter used shall have an interface in accordance with ISO 45 installed in the housing defined in Figure 4.

4.6 Test Methods

4.6.1 Examination of Product

Each nozzle shall be subjected to inspection for adherence to the envelope requirements of Figure 1 of this document and to determine that the nozzle meets the requirements of 3.3. The nozzle shall also be examined to determine conformance to the requirements of this specification with respect to materials, interchangeability, construction, weight, locations of accessory ports, and protective coatings. The foregoing shall be noted and recorded.

4.6.2 Calibration

4.6.2.1 Functional - Static

The nozzle shall be attached onto the test adapter (see Figure 4) and the adapter-sealing valve actuated a minimum of five times. Pressure of 413.7 kPa (60 psig) shall be applied to the inlet of the nozzle during at least three of the above cycles. There shall be no evidence of binding of the lever or leakage.

4.6.2.2 Pressure Loss Test

With a setup similar to Figure 5, and the test adapter in accordance with Figure 4, pressure loss data shall be obtained for flow rates defined in the following paragraphs. When testing Class D-1R, D-2R, D-3R, and R nozzles (with a regulator), it is necessary to block the regulator open to prevent regulator operation due to downstream pressure conditions while conducting these tests. Test results shall be in compliance with the fueling and defueling loss requirements in accordance with 3.3.17.2.

NOTE: When testing nozzles with the optional strainer ball valve, it is necessary to lock the ball valve in the refuel or defuel position while conducting these tests.

4.6.2.2.1 Fueling Mode

With an inlet pressure of 275.8 kPa (40 psig) minimum, a pressure loss test shall be performed with fuel flow rates from 378 to 2271 L/min (100 to 600 gpm), in 378 L/min (100 gpm) increments. The results of the test shall be reported.

4.6.2.2.2 Defueling Mode

A pressure loss test shall be performed with fuel flow rates from 0 to 1136 L/min (300 gpm), in 189 L/min (50 gpm) increments. The results of the test shall be reported.

4.6.3 Regulator Performance (Class D-1R, D-2R, D-3R, and R Nozzles Only)

4.6.3.1 Test Setup

The test setup shall have the following minimum features:

a. Capable of producing pressures downstream of the aircraft adapter of at least the regulator setting (backpressure) at rated flow rate.

b. Have a controlled shutoff valve that will close in 0.5 second at 2271 L/min (600 gpm).

c. The test nozzle shall incorporate a regulator with the appropriate setting. The regulator shall not be blocked in the open position for this test.

d. The setup in Figure 5 shall be used.

The system shall be instrumented with pressure transducers (sensitive enough for the data required) mounted in both pressure taps. The downstream transducer will be capable of recording the pressures generated in the line downstream of the aircraft adapter under the test conditions. A strip chart or other suitable recording device shall be used to monitor the pressures obtained during the tests.

4.6.3.1.1 Except for the surge test in 4.6.3.2.3, the test setup, including the test nozzle and upstream plumbing shall include a minimum of:

a. 22.9 m (75 feet) of 101.6 mm (4 inches) diameter pipe

b. 9.2 m (30 feet) of 101.6 mm (4 inches) intake hose

NOTE: All hose referenced herein shall be aviation refueling type in accordance with EI 1529.

c. 6 m (20 feet) of 101.6 mm (4 inches) rigid pipe work

d. 6 m (20 feet) of 76.2 mm (3 inches) aviation refueling hose connected to the test nozzle

4.6.3.1.2 For the surge test in 4.6.3.2.3, the hose attached to the nozzle shall be 63.5 mm (2-1/2 inches) diameter and 22.9 m (75 feet) long.

4.6.3.1.3 A pressure control system that does not attenuate downstream pressures shall be used to supply the appropriate inlet pressures during the testing.

4.6.3.2 Tests

The following tests shall be conducted on each nozzle type and class except when noted otherwise:

4.6.3.2.1 Pressure Limitation

With the test unit inlet pressure maintained at a constant 413.7 kPa (60 psig ± 2 psig) and using the downstream control valve, the flowrate through the unit shall be adjusted to 0 to 2271 L/min to 0 (0 gpm, 100 gpm, 200 gpm, 300 gpm, 400 gpm, 500 gpm, 600 gpm, 500 gpm, 400 gpm, 300 gpm, 200 gpm, 75 gpm, 50 gpm, 25 gpm, and 0 gpm). At each flow rate the outlet pressure of the unit shall be measured and recorded.

4.6.3.2.2 The test shall be repeated with an inlet pressure of 482.7 kPa (70 psig), 551.6 kPa (80 psig), 620.6 kPa (90 psig), 689.5 kPa (100 psig), 758.5 kPa (110 psig), and 827.4 kPa (120 psig). The control pressure shall be within the requirements of 3.3.17.3. Sufficient measurements shall be obtained to plot the results in a curve of control pressure versus flow rate for each inlet pressure setting.

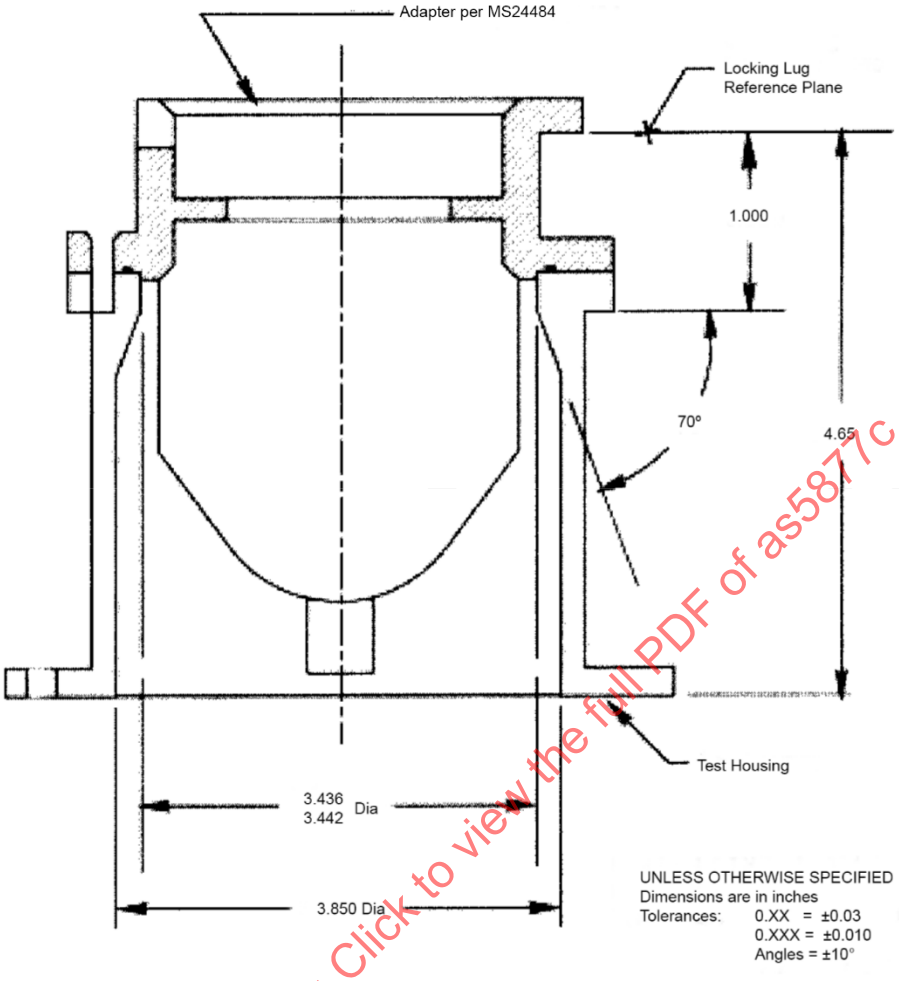
Plot the results in a curve of control pressure versus flow rate for each inlet pressure setting (seven curves).

4.6.3.2.3 Surge Control

The inlet pressure to the nozzle shall be set at approximately 413.7 kPa (60 psig). The downstream control valve shall be set to a backpressure of 86.2 kPa (12.5 psig) at 2271 L/min (600 gpm) to simulate an empty aircraft. The downstream valve shall be closed within 0.50 second and the downstream pressure surge shall be measured. Repeat the test with flow rates of 1893 to 378 L/min (500 to 100 gpm), in 378 L/min (100 gpm) increments, by adjusting the downstream control valve opening. Repeat the test at 551.6 kPa (80 psig) and 689.5 kPa (100 psig) inlet pressures. The surge pressure downstream of the nozzle (in the simulated aircraft adapter) shall not exceed 827.4 kPa (120 psig).

4.6.3.2.4 Surge Control - Failure Condition

The nozzle for this test shall not be modified from the original condition. The test in 4.6.3.2.3 shall be repeated at 551.6 kPa (80 psig) nozzle inlet pressure with the hose end control valve vent chamber full of fuel to simulate seal failure. The surge pressure shall not exceed 827.4 kPa (120 psig).

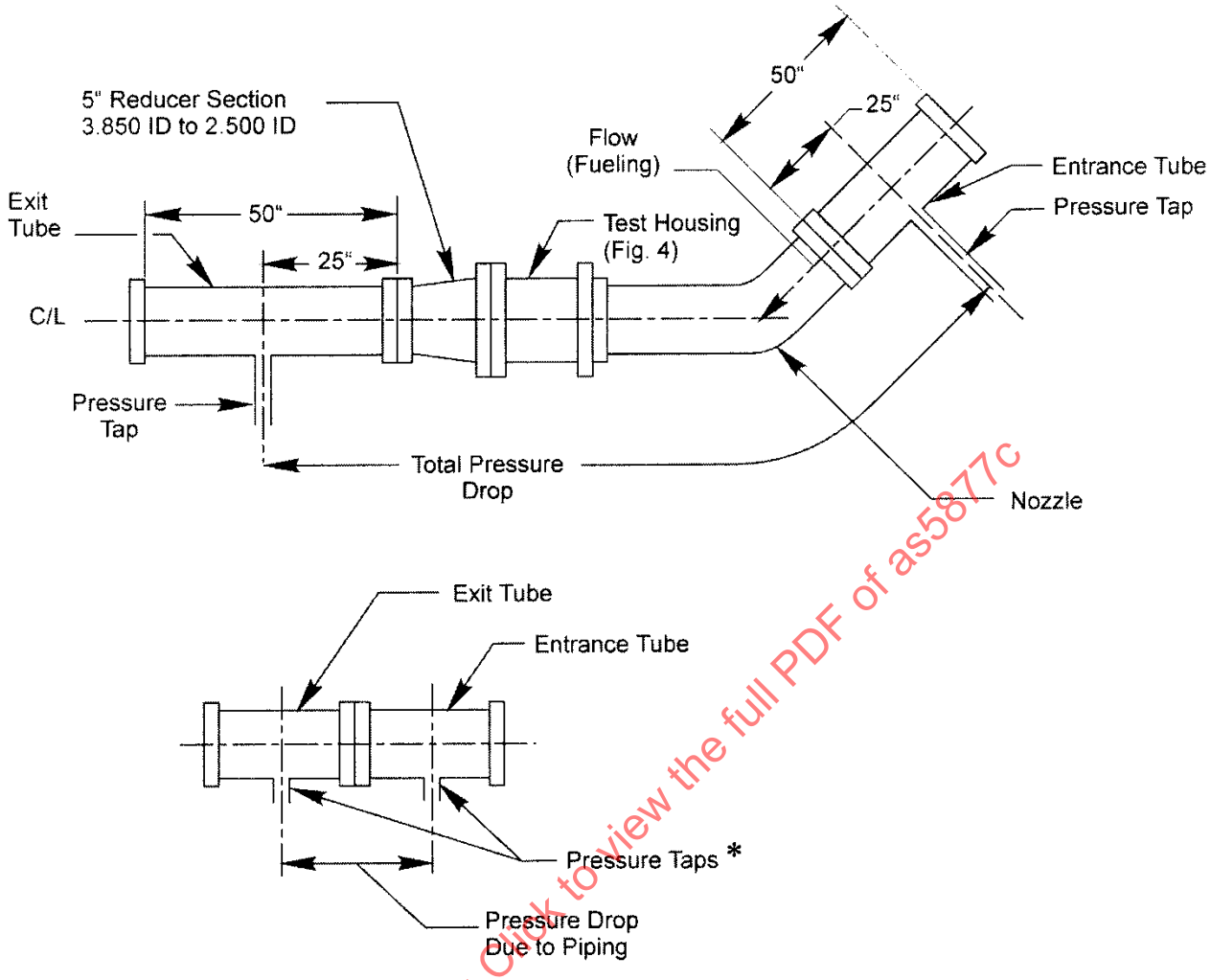


Notes:

1. Dimensions are in inches for clarity. Metric conversions for the dimensions shown above are as follows:

Inches	Millimeters	Inches	Millimeters
.010	.25	3.442	87.43
.030	.76	3.850	97.79
1.000	25.40	4.65	118.11
3.436	87.27		

Figure 4 - Test adapter configuration



△ P = Total Pressure Drop - Drop Due to Piping

Nominal Tube Size, Entrance and Exit Tubes = 2 ½" Schedule 40

*Include all fittings needed to connect Test Nozzle to Entrance Tube and connect Reducer to Exit Tube.

Figure 5 - Pressure drop test setup

4.6.3.2.5 Lockout

With 551.6 kPa (80 psig) inlet pressure, and the downstream shut-off valve closed, the outlet pressure shall be observed for 1 minute. The outlet pressure shall not increase by more than 68.9 kPa (10 psig) above the applicable spring setting.

4.6.3.2.6 Pressure Relief

The outlet of the open nozzle shall be attached to a pressure source of 551.6 kPa (80 psig). The inlet of the nozzle shall be plugged, and a pressure gauge shall be installed in the plug. Upon application of the pressure the inlet pressure gauge shall increase to a minimum of 482.7 kPa (70 psig) within 60 seconds.

4.6.3.2.7 Stability

The test in 4.6.3.2.1 shall be repeated using a valve that will increase the inlet pressure from 413.7 to 689.5 kPa (60 to 100 psig) in less than 1.0 second. Repeat by decreasing the inlet pressure back to the starting point in the same time frame after flow rate has been stabilized at the higher pressure. Repeat the test with 689.5 kPa (100 psig) inlet and rapidly increase the backpressure from 137.9 to 344.8 kPa (20 to 50 psig) in less than 1.0 second. There shall be no evidence of instability of the hose end control valve during these tests.

4.6.4 Leakage

4.6.4.1 Connected

With the nozzle connected to the test adapter and the nozzle operating lever in the full open position, the leakage test shall be conducted over a range from 68.9 to 413.7 kPa (10 to 60 psig) in 68.9 kPa (10 psig) increments. The pressure shall be maintained at each increment for at least 1 minute. There shall be no evidence of external fuel leakage from the nozzle and air leakage inward into the nozzle shall not exceed 50 scc/min during any part of the leakage tests. Acceptance Inspection testing shall be conducted only at pressures of 34.5 kPa and 413.7 kPa (5 psig and 60 psig).

4.6.4.2 Disconnected

With the nozzle disconnected from the adapter, fuel pressures of from 0 to 413.7 kPa (0 to 60 psig) in 68.9 kPa (10 psig) increments, and then air at pressures from -82.74 to 0 kPa (-12 to 0 psig) shall be applied to the nozzle inlet. The pressure shall be maintained at each increment for at least 1 minute. There shall be no evidence of external fuel leakage from the nozzle and air leakage inward into the nozzle shall not exceed 50 scc/min during any part of the leakage tests. Acceptance inspection testing shall be conducted only at pressures of 34.5 kPa and 413.7 kPa (5 psig and 60 psig).

4.6.4.3 Regulator (Class D-1R, D-2R, D-3R, and R Only)

With the nozzle disconnected from the adapter, fuel pressures of from 0 to 413.7 kPa (0 to 60 psig) in 68.9 kPa (10 psig) increments shall be applied to the nozzle inlet. The pressure shall be maintained at each increment for at least 5 minutes. The nozzle shall be positioned such that the axis of the unit is parallel to the ground and the ambient vent port on the regulator is pointed in a downward position. The breather plug of the regulator shall be removed for this test. There shall be no evidence of leakage in the form of a free-falling drop from the ambient sense port. Upon initial calibration, there shall be no evidence of wetting during the test. Acceptance inspection testing shall be conducted only at pressures of 34.5 kPa and 413.7 kPa (5 psig and 60 psig). No wetting or leakage shall be allowed during acceptance inspection testing.

4.6.4.4 Interface (Disconnect) Leakage

The volume of fuel not contained when the nozzle is disconnected from the adapter shall not exceed 10 mL as verified by test.

4.6.5 Fuel Resistance and Extreme Temperature

A fuel resistance and low temperature test shall be conducted in accordance with Table 6.

4.6.6 Swivel Endurance

The nozzle swivel shall be wear-tested by loading the nozzle with a 135.6 N-m (100 ft-lb) bending load (see Figure 2) and turning the swivel 2000 times through at least a 45-degree arc. During this test, the nozzle shall be pressurized with test fluid to 379.2 kPa (55 psig). Following this loading, the nozzle shall successfully complete the proof pressure test of 4.6.10.