



SURFACE VEHICLE STANDARD	J2600™	OCT2015
	Issued 2001-10 Revised 2015-10	
	Superseding J2600 NOV2012	
Compressed Hydrogen Surface Vehicle Fueling Connection Devices		

RATIONALE

SAE J2600 has been revised to reflect the incorporation of additional geometries for different pressures, and to modify, add, or delete testing requirements based on lessons learned as the state of the art has progressed. In addition, the document moved from a Recommended Practice to Standard.

TABLE OF CONTENTS

1.	SCOPE	2
2.	REFERENCES	3
3.	DEFINITIONS	4
4.	REQUIREMENTS	6
5.	TYPE (DESIGN VERIFICATION) TESTS.....	14
6.	PRODUCTION TESTS	36
7.	MARKING	37
8.	DOCUMENTATION	38
9.	NOTES	38

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be revised, reaffirmed, stabilized, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2015 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

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
<http://www.sae.org>

SAE WEB ADDRESS:

Full document details: [SAE J2600_201510](http://www.sae.org/technical/standards/J2600_201510)

SAE values your input. To provide feedback on this Technical Report, please visit http://www.sae.org/technical/standards/J2600_201510

Appendix A	(Informative only)	39
Figure 4.3.2.1	H11 to H50 Hydrogen receptacles	9
Figure 4.3.2.2	H70 Hydrogen receptacle	10
Figure 4.3.5.2	Clearance for receptacles of pressure classes greater than H25	11
Figure 5.9.2	Test arrangement for dropping test	19
Figure 5.12.1.1	H11 to H50 worn fit test fixture	22
Figure 5.12.1.2	H70 Worn fit test fixture	23
Figure 5.12.2.1	H11 to H50 Loose fit test fixture	24
Figure 5.12.2.2	H70 Loose fit test fixture	25
Figure 5.12.3.1	H11 to H50 Tight fit test fixture	26
Figure 5.12.3.2	H70 Tight test fixture	27
Figure 5.18.A	Use of shims to create a misconnected connector	34
Figure 5.18.B	Adjustment of stop ring position to accommodate a shim	34
Table 3.9.1	Pressure class designations	5
Table 5.1.2	Test fixture tooling dimensions	15
Table 5.12	Test fixture selection for nozzle durability tests	21
Table 5.18	Misconnected nozzle test configurations	33
Table A1	Table of nozzle characteristics	39

1. SCOPE

SAE J2600 applies to the design and testing of Compressed Hydrogen Surface Vehicle (CHSV) fueling connectors, nozzles, and receptacles. Connectors, nozzles, and receptacles must meet all SAE J2600 requirements and pass all SAE J2600 testing to be considered as SAE J2600 compliant.

This document applies to devices which have Pressure Classes of H11, H25, H35, H50 or H70.

1.1 Purpose

SAE J2600 is intended to:

- Prevent vehicles from being fueled with a Pressure Class greater than the vehicle Pressure Class;
- Allow vehicles to be fueled with Pressure Class equal to or less than the vehicle Pressure Class,
- Prevent vehicles from being fueled by other compressed gases dispensing stations;
- Prevent other gaseous fueled vehicles from being fueled by hydrogen dispensing stations.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue of SAE publications shall apply.

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.

SAE J2574	Fuel Cell Vehicle Terminology
SAE J2578	Recommended Practice for General Fuel Cell Vehicle Safety
SAE J2579	Technical Information Report for Fuel Systems in Fuel Cell and Other Hydrogen Vehicles
SAE J2601	Fueling Protocols for Light Duty Gaseous Hydrogen Surface Vehicles
SAE J2601/2	Fueling Protocol for Gaseous Hydrogen Powered Heavy Duty Vehicles
SAE J2601/3	Fueling Protocol for Gaseous Hydrogen Powered Industrial Trucks
SAE J2719	Hydrogen Fuel Quality for Fuel Cell Vehicles
SAE J2799	70 MPa Compressed Hydrogen Surface Vehicle Fueling Connection Device and Optional Vehicle to Station Communications

2.1.2 IEEE Publications

Available from IEEE Operations Center, 445 Hoes Lane, Piscataway, NJ 08854-4141, Tel: 732-981-0060, www.ieee.org.

IEEE/ASTM SI 10 Use of the International System of Units: The Modern Metric System

2.1.3 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 B117-09 Standard Practice for Operating Salt Spray (Fog) Apparatus.

ASTM D572 – 04 (Reapproved 2009) Standard Test Method for Rubber - Deterioration by Heat and Oxygen

2.1.4 ISO Publications

Available from American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, Tel: 212-642-4900, www.ansi.org.

- ISO 1817:1998 Rubber, vulcanized or thermoplastic - Determination of the effect of liquids
- ISO 9227:1990 Corrosion tests in artificial environments - Salt spray tests
- ISO 15501-1:2001 Road vehicles - Compressed natural gas (CNG) fuel systems - Part 1: Safety
- ISO 15501-2:2001 Road Vehicles - Compressed natural gas (CNG) fuel systems - Part 2: Test methods
- ISO 12103-1; 1997 Road Vehicles - Test dust for filter evaluation - Part 1: Arizona test dust.

2.1.5 ISA Publications

Available from ISA, 67 Alexander Drive, P.O. Box 12277, Research Triangle Park, NC 27709

ANSI/ISA-75.02.01:2008 Control Valve Capacity Test Procedures

2.1.6 BSI Publications

Available from BSI, 389 Chiswick High Road, London, W4 4AL, United Kingdom

EN 60534 Industrial-process control valves - all parts

2.1.7 GM Worldwide Engineering Standard

GMW14872-2006 Cyclic Corrosion Laboratory Test

3. DEFINITIONS

See SAE J2574 for fuel cell vehicle terminology.

3.1 AIR, DRY

Air with a maximum dew point of -40°C .

3.2 CONNECTOR

A joined assembly of a nozzle and receptacle which permits rapid connection and disconnection of fuel supply hose to the vehicle fuel system.

3.3 CYCLE

The process of making a positive connection between the nozzle and the receptacle, pressurizing to Design Pressure, depressurizing and disconnecting.

3.4 HELIUM, DRY

Helium which meets or exceeds the following quality level; maximum water content of 5 ppm, product grade of 4.5 (99.995).

3.5 HYDROGEN, DRY

Hydrogen which meets or exceeds the quality level in J2719.

3.6 LEAK TEST GAS

Dry hydrogen or helium, preferably hydrogen. Adequate safety precautions shall be taken when testing with hydrogen.

3.7 NOZZLE

Device connected to a fuel dispensing system, which connects to the CHVS receptacle and permits transfer of fuel.

TYPE A - A nozzle for use with dispensing hoses that may remain fully pressurized at dispenser shutdown. The nozzle shall not allow gas to flow until a positive connection has been achieved. The nozzle shall be equipped with an integral valve or valves, incorporating an operating mechanism which first stops the supply of gas and safely vents the trapped gas before allowing the disconnection of the nozzle from the receptacle. The operating mechanism shall ensure the vent connection is open before the release mechanism can be operated and the gas located between the nozzle shut-off valve and the receptacle check valve is safely vented prior to nozzle disconnection.

TYPE B - A nozzle for use with dispensing hoses that may remain fully pressurized at dispenser shutdown. A separate three-way valve connected directly, or indirectly, to the inlet of the nozzle is required to safely vent trapped gas prior to nozzle disconnection. The nozzle shall not allow gas to flow until a positive connection has been achieved. Venting is required prior to disconnection of the nozzle. External three-way valves shall be constructed and marked so as to indicate clearly the open, shut and vent positions.

TYPE C - A nozzle for use with dispensing hoses which are depressurized (0.5 MPa and below) at dispenser shutdown. The nozzle shall not allow gas to flow until a positive connection has been achieved.

3.8 POSITIVE LOCKING MEANS

A feature which requires actuation of an interlocking mechanism to verify proper connection of the connector before pressure is applied.

3.9 PRESSURE CLASS

Pressure Class is a non-dimensional rating for hardware that defines the operational pressure and temperature limits of a component. The pressure class is denoted by the letter "H" followed by the nominal working pressure in MPa.

Table 3.9.1 - Pressure class designations

Pressure Class	Nominal Working Pressure @ 15°C	Design Pressure (1.5 x NWP)
H11	11 MPa	16.5 MPa
H25	25 MPa	37.5 MPa
H35	35 MPa	52.5 MPa
H50	50 MPa	75.0 MPa
H70	70 MPa	105.0 MPa

3.10 PRESSURE, DESIGN (OR RATED)

The maximum pressure at the most severe temperature level that a component will experience in actual service. The Design Pressure is to be, at a minimum, 150% of the Nominal Working Pressure for the purpose of this document. For further information regarding all pressure definitions used for hydrogen fueling system refer to SAE J2579.

3.11 PRESSURE, NOMINAL WORKING

The steady state pressure of a fully fueled vehicle storage tank at the given gas temperature of 15 °C (this defines a full tank gas density). For further information regarding all pressure definitions used for hydrogen fueling system refer to SAE J2579.

3.12 PROTECTIVE CAP

A means to prevent road dirt and other contaminants from getting into the inlet of the vehicle receptacle

3.13 RECEPTACLE

Device connected to a vehicle or storage system which receives the station nozzle and permits transfer of fuel. This may also be referred to as a fuelling inlet.

4. REQUIREMENTS

4.1 Quality Assurance

4.1.1 General

Quality system programs shall be established and operated to show that components will be produced in accordance with the qualified design. Quality systems shall be in accordance with 4.1.2, Approved Quality Systems.

4.1.2 Approved Quality System

Quality management systems shall be registered for compliance with *ISO 9001, Quality Management Systems Requirements*, by an accredited registrar. Other systems which incorporate *ISO TS 16949, Quality management systems - Particular requirements for the application of ISO 9001:2000 for automotive production and relevant service part organizations*, *ISO 9000*, such as *QS 9000, Quality System Requirements*, are acceptable.

Comparable quality systems shall be required of suppliers to components manufacturers. The manufacturers shall verify that their suppliers meet the requirements of 4.1.2, Approved Quality System.

4.2 General Requirements

4.2.1 Testing requirements

4.2.1.1 All test procedures listed in this document are type (design verification) test procedures unless otherwise noted.

4.2.1.2 All products must pass all tests to be considered to be in compliance with standard.

4.2.1.3 Communications hardware, such as IrDA, which is used to meet the requirements of SAE J2601 and/or SAE J2799 and is supplied with the nozzle by the manufacturer shall be attached to the nozzle and subjected to all of the nozzles tests. The communications hardware is to be demonstrated to be operating correctly upon completion of the all type and quality testing.

4.2.2 Pressure class interchangeability: The nozzle and receptacle designs noted herein shall:

- Prevent vehicles from being fueled with a Pressure Class greater than the vehicle Pressure Class;
- Allow vehicles to be fueled with Pressure Class equal to or less than the vehicle Pressure Class,
- Prevent hydrogen vehicles from being fueled by other compressed gases dispensing stations
- Prevent other gaseous fueled vehicles from being fueled by hydrogen dispensing stations.

This requirement is met by completing section 5.2 and successfully conducting a leak test per section 5.6.

4.2.3 Temperature Range: The nozzle and receptacle designs noted herein shall:

- Shall be designed to operate properly with a local ambient temperature of –40 to 65 °C.
- Shall be designed to operate properly for a gas process temperature –40 to 85 °C for H11 and H25 hardware.
- Shall be designed to operate properly for a gas process temperature –45 to 85 °C for H35, H50 and H70 hardware.

This requirement is met by the completing section 5.6 and section 5.7.

4.2.4 Features

- 4.2.4.1 General - Nozzles and receptacles made to this document shall be designed in accordance with reasonable concepts of safety, durability and maintainability as demonstrated by the successful completion of all of the type tests in section 5.
- 4.2.4.2 Design and Documentation - Nozzles and receptacles shall be well fitted and manufactured in accordance with good engineering practice. All specifications as to construction set forth herein may be satisfied by the construction actually prescribed or such other construction as will provide at least equivalent performance. Following the pressure technology requirements of ASME, JSME and/or the EC Pressure Equipment Directive shall be considered prima facie evidence of meeting this requirement.
- 4.2.4.3 Damage - Nozzles and receptacles shall be designed to be secure against displacement, distortion, warping or other damage.

This requirement is met by the completing sections 5.2, 5.6, 5.9 and 5.14.

- 4.2.4.4 Electrical Continuity - Nozzles and receptacles shall be constructed to maintain electrical continuity under normal and reasonable condition of handling and usage.

This requirement is met by completing the relevant portion section 5.12.

- 4.2.4.5 Materials of Construction - Materials used in the construction of nozzles, receptacles and dust caps shall be non-sparking or spark-reducing.
- 4.2.4.6 Contamination - Nozzles and receptacles shall be designed so that they are either tolerant of solid contamination, or have a means to protect themselves from said contamination when connected or disconnected. For example, the requirement is met if the receptacle has a filter upstream of adequate size to protect the functionality of the check valve. A receptacle shall have a means to prevent the ingress of fluids and foreign matter when disconnected.

This requirement is met by the completing the relevant portion section 5.15.

- 4.2.4.7 Thermal Cycles - The nozzle and receptacle shall be able to withstand thermal cycles.

This requirement is met by the completing the relevant portion section 5.16.

4.2.5 Units

- 4.2.5.1 Pressure - All references to pressures (MPa) throughout this document are to be considered gauge pressures unless otherwise specified.
- 4.2.5.2 System - SI Units stated herein are in accordance with the IEEE/ASTM SI 10.

4.2.6 Compatibility

- 4.2.6.1 Test medium - For the purposes of this document, compressed hydrogen gas should meet the minimum requirements of SAE J2719.
- 4.2.6.2 Hydrogen - Nozzles and receptacles shall be manufactured of materials suitable and compatible for use with compressed hydrogen at the pressure and the temperature ranges to which it will be subjected.
- 4.2.6.3 DI-Water - All pressure bearing and wetted components shall also be made from adequate material that is compatible with de-ionized water or distilled water.
- 4.2.6.4 Seals - Seals and non-metallic synthetic material shall be a material that is suitable for this application (compatible with hydrogen and compressor oil, synthetic or mineral).

This requirement is met by the completing section 5.4 and 5.5.

- 4.2.6.5 Corrosion Resistance - Nozzles and receptacles shall not sustain corrosion or loss of protective coatings.

This requirement is met by the completing section 5.13.

4.3 Receptacle

4.3.1 General Requirements

- 4.3.1.1 The failure of any test conducted with the receptacle and nozzle test samples shall constitute a failure of the receptacle design.

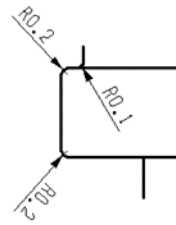
4.3.2 Outside Geometry

- 4.3.2.1 Receptacles shall comply with the design specifications detailed in Figures 4.3.2.1 and 4.3.2.2.

	H11	H25	H35	H50
a	TBD	30MIN	35MIN	TBD
b	TBD	25±0.1	30±0.1	TBD

REFERENCE SEALING SURFACE
FOR A #110 O-RING WITH THE
DIMENSIONS: I.D. = 9.19±0.13,
WIDTH = 2.62±0.08

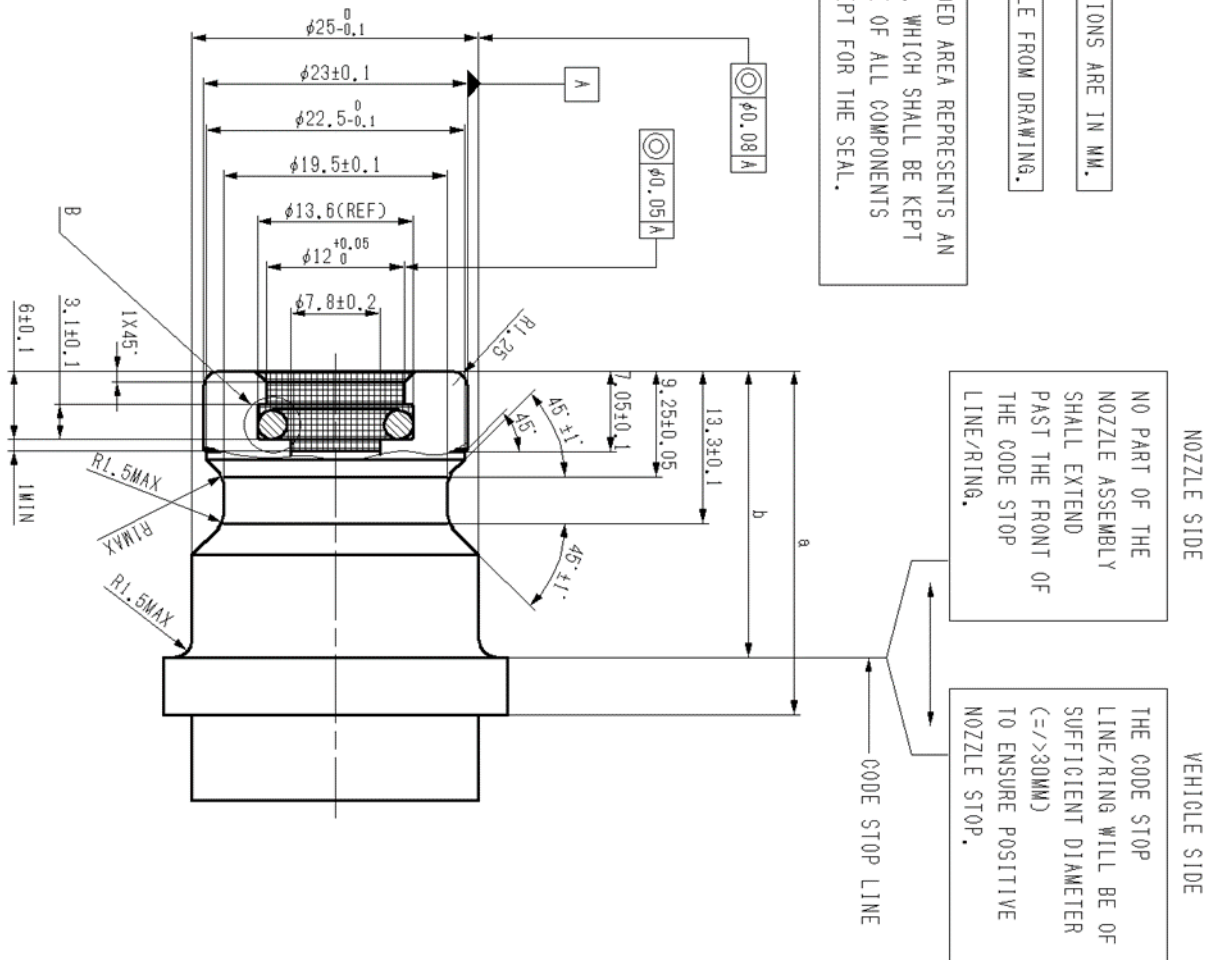
DETAIL "B"



SHADED AREA REPRESENTS AN
AREA WHICH SHALL BE KEPT
FREE OF ALL COMPONENTS
EXCEPT FOR THE SEAL.

DO NOT SCALE FROM DRAWING.

ALL DIMENSIONS ARE IN MM.



MATERIAL SHALL DEMONSTRATE HYDROGEN COMPATIBILITY AS 4.2.6 AND A MINIMUM HARDNESS OF 80 ROCKWELL B(HRB), UNLESS OTHERWISE SPECIFIED, SURFACE FINISH SHALL BE $0.4\mu\text{m}$ TO $3.2\mu\text{m}$.

Figure 4.3.2.1 - H11 to H50 hydrogen receptacles



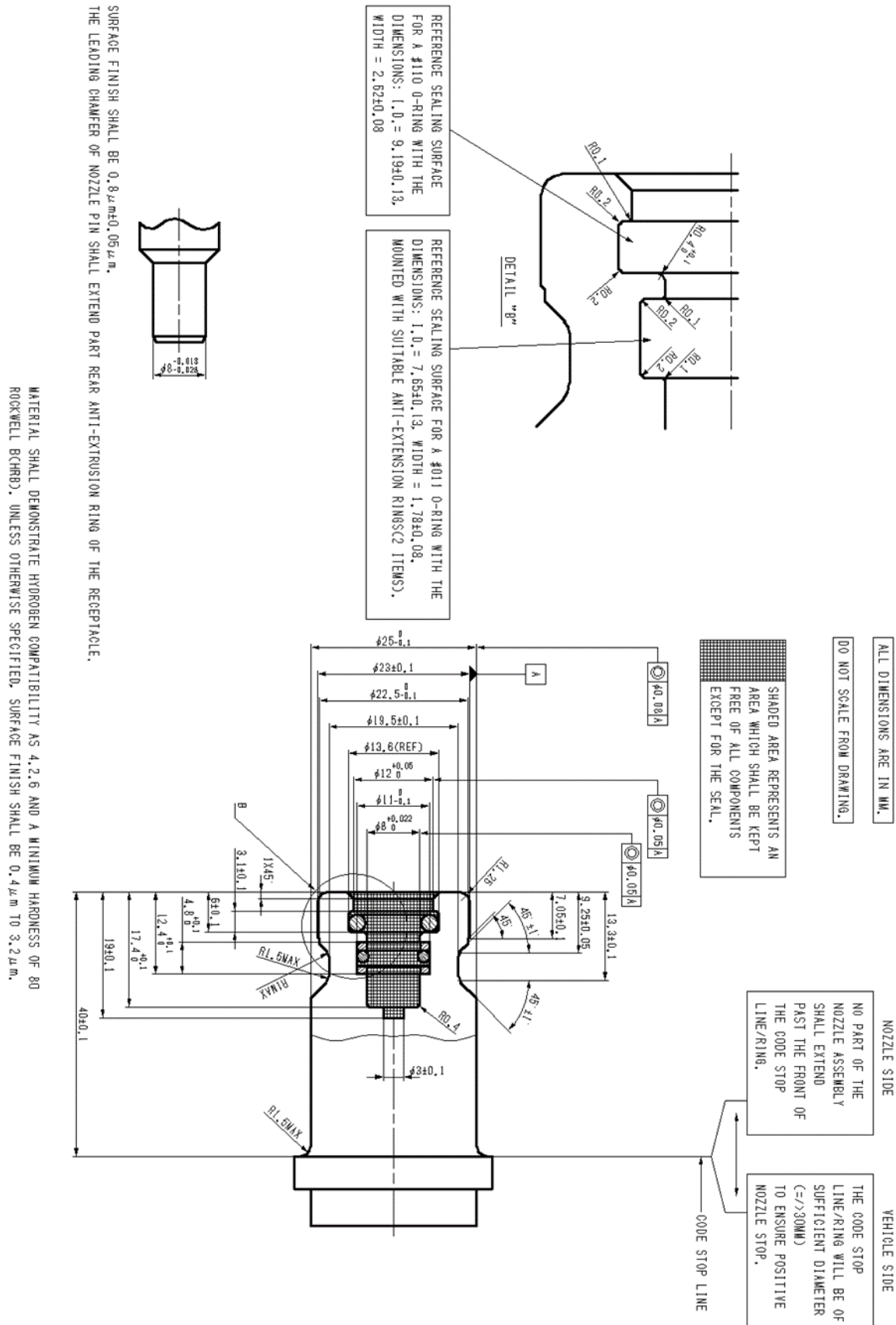


Figure 4.3.2.2 - H70 Hydrogen receptacle

4.3.3 Flow Requirements (Cv)

The minimum Cv value for the receptacle shall be 0.35 or as listed in the manufacturer's literature. Determination may be by test or analysis. Measuring method is to be documented with the Cv value. Refer to ANSI/ISA-75.02.01 or the EN 60534 series of documents for guidance.

4.3.4 Wear requirements (Cycles to minimum tolerance)

Receptacles shall be designed for a life of 15 000 cycles and 15 years with manufacturer specified maintenance.

This requirement is met by the completing section 5.12.

4.3.5 Bulkhead Requirements

4.3.5.1 Clearance - Receptacle designs which employ means on the back diameter to accommodate mounting, or for mounting accessories or marking purposes, shall not have such means extend beyond the back diameter dimensions of the profile specified in section 4.3.2, as applicable.

Acceptable means shall include wrench flats, protective cap anchoring grooves, use of hex stock, undercutting for marking, and threads for protective caps. Such receptacle designs shall not compromise proper nozzle interchangeability.

4.3.5.2 Mounting - The receptacle shall be mounted on the vehicle in compliance with the following:

- For pressure classes less than or equal to H25, the receptacle shall be mounted on the vehicle in compliance with SAE J2578 and ISO 15501.
- For pressure classes greater than H25, the receptacle shall be mounted on the vehicle in compliance with SAE J2578 and the figure below.

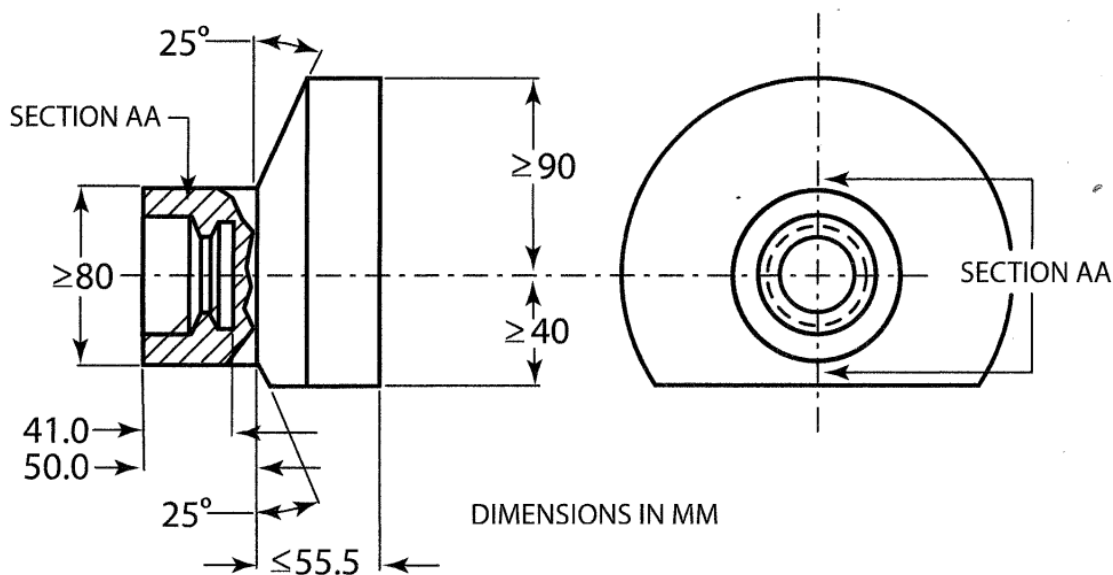


Figure 4.3.5.2 - Clearance for receptacles of pressure classes greater than H25

4.3.6 Check Valve

4.3.6.1 Sealing - The receptacle shall be equipped with an internal check valve to prevent the escape of gas.

4.3.6.2 Valve Design - The check valve shall be of the non-contact type, opening by differential pressure only

4.3.7 Vehicle Interconnect

4.3.7.1 Receptacle Vibration Resistance - Following completion of vibration as specified in section 5.10, receptacles shall not be damaged and shall comply with the receptacle leakage tests in section 5.6 and 5.8.

4.3.7.2 Low and High Temperatures - The receptacles shall be evaluated over the expected operating range of temperatures and pressures for leakage. This is demonstrated by completing sections 5.6, 5.7 and 5.17 (for pre-cooled fuel).

4.3.7.3 Receptacle Cycles - A receptacle shall be capable of withstanding 15 000 cycles of operation as specified in section 5.12.

4.3.7.4 Hydrostatic (or Ultimate) Strength – The receptacle shall demonstrate itself capable of containing fluid when hydrostatically tested to 3 times the Nominal Working Pressure of the receptacle as specified in section 5.8.

4.3.7.5 Abnormal Load - The barrel of receptacle with the nozzle attached is not damaged when an abnormal load (both axial and moment) is applied to the nozzle. This requirement is met by completing sections 5.11 and 5.20

4.3.7.6 Air Intrusion

The allowable volume of air that can be trapped in the receptacle when mated to the nozzle shall not exceed 3 cm³ at room temperature and pressure.

This requirement can be met by calculation based on the component drawings.

4.3.7.7 Pre-Cooled Hydrogen Exposure Test

Verify that the H35 and H70 hardware can withstand exposure to pre-cooled hydrogen during fuelling. This is demonstrated by successfully completing section 5.17.

4.3.7.8 Deformation of Assembled parts.

The receptacle/fuel storage connection shall be able to withstand normal abuse encountered in the installation and maintenance process without damage or deformation to the joint. Additionally, leakage at the joint is not permitted. This is demonstrated by successfully completing section 5.14.

4.4 Protective Cap (mounted on vehicle)

4.4.1 General Requirements

4.4.1.1 Foreign Debris - Protective caps are intended to protect the receptacle from foreign debris.

4.4.1.2 Pressure Containment - Protective caps are not intended to hold pressure.

4.4.1.3 Attachment - All protective caps must have a retainer to attach them to the receptacle or vehicle.

4.4.1.4 Vibration - Protective caps shall not be damaged or dislodged following completion of vibration as specified in section 5.10.