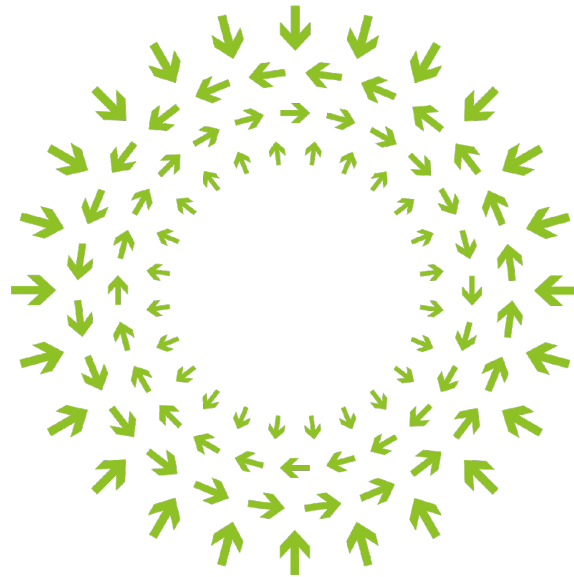




OPEN

Compute Project

Cold Plate Sub-Project

MQD/MQDB OCP Design Specification

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Design Specification
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AWS

2. Compliance with OCP Tenets

This contribution adheres to the OCP Tenets by freely sharing the specification of a production tested QD, enabling easier manufacturing and service of liquid cooled system trays, and enabling multiple size / flow rate choices depending on application.

2.1. Openness

The MQD/MQDB profile is published with interchange rules, dimensional limits, and validation tests so multiple qualified suppliers can build interoperable plugs and sockets for the same dash size. Reference geometry is supplied for context while this specification remains the normative source for compliance.

2.2. Efficiency

The connector family targets drip-free, hot-pluggable serviceability with bounded coupling forces and published Cv / pressure / flow ratings to reduce waste, thermal downtime, and service labor compared with unmanaged fluid connections in liquid-cooled racks.

2.3. Impact

Defining the MQD/MQDB interface within the OCP modular design framework accelerates adoption of direct liquid cooling by establishing a reusable mechanical/fluid building block for hyperscale and AI infrastructure partners.

2.4. Scale

Multiple dash sizes (02, 03, 04 variants) share a common validation philosophy so designs can scale from lab prototypes to fleet deployments without re-architecting the fluid interconnect strategy.

2.5. Sustainability

Shelf-life and durability tests, ROHS-aligned wetted materials guidance, and shipping-plug recommendations reduce coolant spills, scrap from contamination, and unplanned hardware churn.

3. Design Specification

3.1. Description

This document defines the technical specifications for the MGX Quick Disconnect (MQD) and MQDB used in non-combustible single-phase (water/glycol) systems for liquid cooling of electronics. The MQDs and MQDBs defined are used inside the pending OCP contribution of MGX v1.2.0 Accelerated Computing Rack and Trays designs, which is derived from, but not fully compatible with the previous MGX 1.1 OCP contribution.

This specification defines the interface dimensions for interchangeability and defines acceptable performance for a hand-mate, drip-free, hot-pluggable, fluid line connector. The MQD and MQDB maintains a leak-tight seal under pressure when coupled and on both sides when decoupled.

The 3D CAD model is provided for reference purposes only. All design, dimensional, and technical requirements are governed exclusively by the specification documents.

3.2. User Requirements/User Stories

The quick disconnects specified in this document are used in the MGX liquid cooled trays and intended for use in any liquid cooled IT hardware.

3.3. Solution Architecture

The quick disconnects detailed in this document include hand plug version, blind mate version as well as the ability to mix those two based on application.

3.4. Terms and Definitions

Plug

The connector component designed to be inserted into the corresponding socket.

Socket

The connector component designed to receive a corresponding plug.

Coupled

The state when the plug and socket are fully engaged and locked together

Coupling

The act of connecting the plug and socket together so that they are locked together to join a fluid line. The method of latching must be using pin latch.

Cv

Flow coefficient defined as $\overline{C_v} = Q/\sqrt{\Delta P}$, where Q is flow rate in gallons/min (GPM) and ΔP is pressure drop in lbs/in² (psi) for water at 60 degrees F

Termination

Both plug and socket have terminations on the ends to connect a tube or pipe to the coupling

QD

Quick Disconnect

MQD

MGX Quick Disconnect

MQDB

MGX Quick Disconnect Blind Mate variant

Break

Act of de-coupling the plug and socket

Make

Act of coupling the plug and socket such that the pair are fully mated and locked

Multi Quick Disconnect

Fully interchangeable with other plug and socket parts meeting the MQD Requirements of the same nominal size

KPI

Key Performance Indicator

NA: Not Applicable

MQD##

Refers to the orifice size of the QD. High numbers mean a larger flow path.

MQDB##

Refers to the orifice size of the QD. High numbers mean a larger flow path.

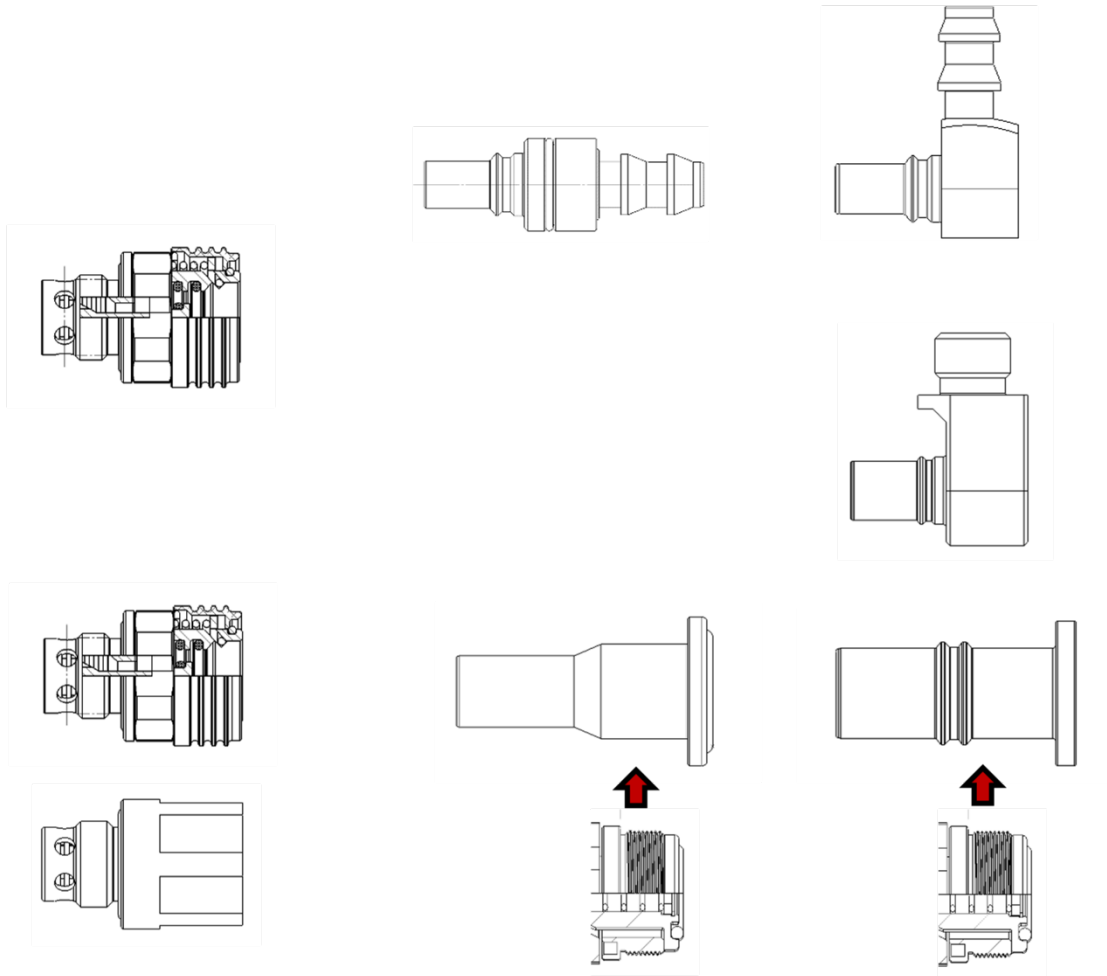


Figure 1: MQD Quick Disconnect Plugs and Sockets

3.5. Environmental Regulatory Compliance and Design

As a minimum supplier shall meet the requirements of IEC62368-1 clause G.15

4. Features and Dimensional Requirements

The following section defines the physical design requirements and performance metrics of the quick disconnects.

4.1. Dimensional Requirements

The following Physical features of the socket shall conform to the dimensions shown in Figure 2a, 2b & 2c of MQD & MQDB Socket Dimensions and given in Table 1a to Table 1e of MQD and MQDB Socket Dimensional Specification. Physical features of the plug shall conform to the dimensions shown in Figure 3a & 3b & 3c, 4a & 4b MQD & MQDB Plug Dimensions and given by Table 2a to Table 2f MQD/MQDB Plug Dimensional Specification. Where no dimension is given the geometry is left to the discretion of the manufacturer and should consider end user (datacenter environment) requirements for fit and function.

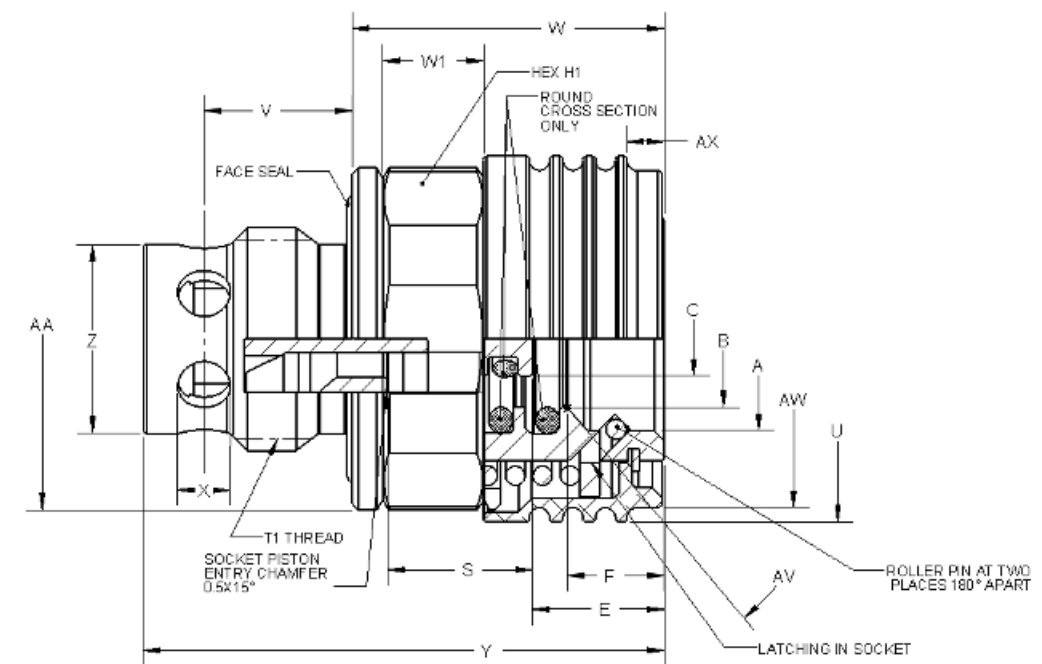


Figure 2a: MQD Socket Dimensions

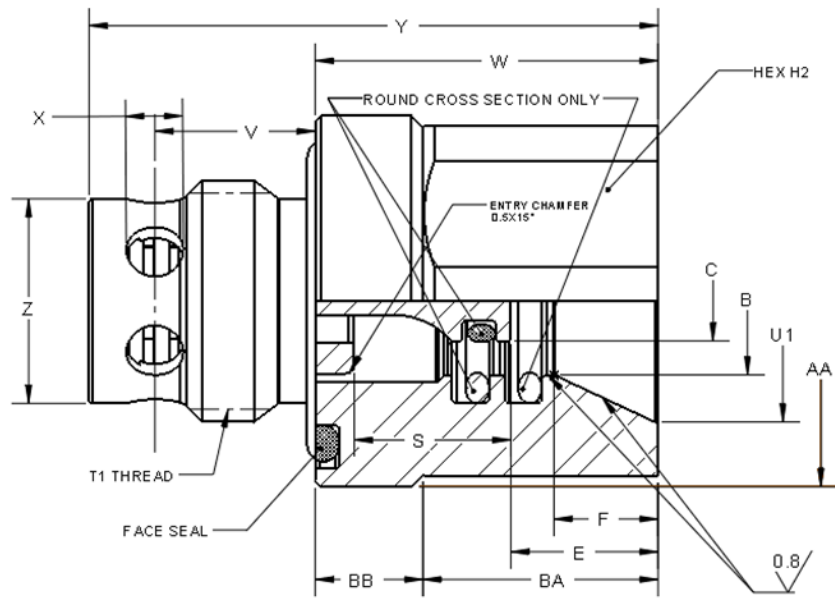


Figure 2b: MQDB02/03 Socket Dimensions

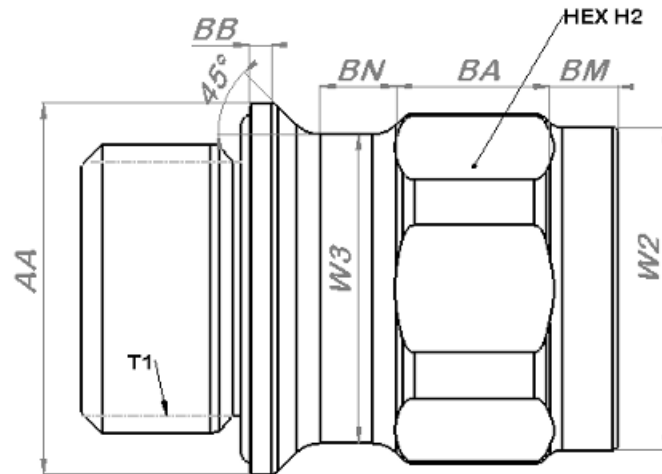


Figure 2c: MQDB04 Socket Dimensions

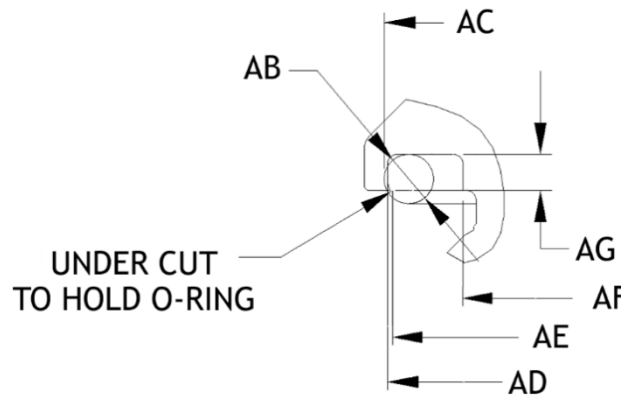


Figure 2d: MQD(B) Plug / Socket Face Seal Dimensions

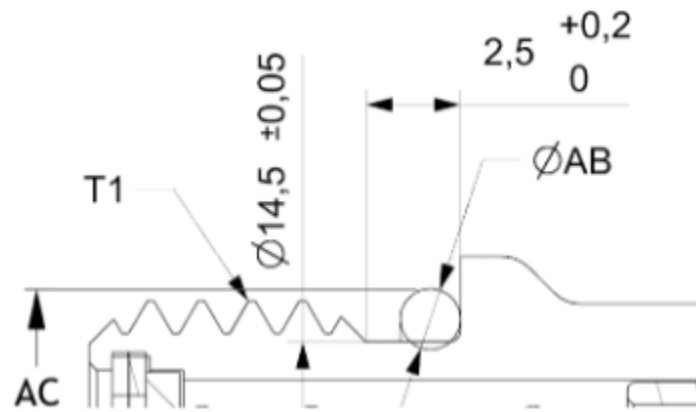


Figure 2e: MQDB04-1 Sealing Dimensions

Table 1a: Socket Dimensional Specification (Dimensions in millimeters)

	Dimension (see Fig 2)	A	B	C	E MQD MQDB	F MQD MQDB	S	H1	U	V	W1
	Tolerance value	±0.05	±0.025	±0.025	+/-0.15	±0.15	Nominal	+0.0 /-0.2	±0.10	±0.15	MIN
SOCKET SIZE	MQD-02	Ø9.00	Ø6.71	Ø3.63	6.50 6.70	4.66 4.81	7.1	15.9	Ø18.00	7.3	5.0
	MQD-03	Ø 10.20	Ø 8.90	Ø 4.93	6.25 6.25	4.31 4.45	7.4	17.0	Ø 18.00	7.5	3.4
	MQD-04 MINI	Ø12.40	Ø11.15	Ø6.60	7.4 NA	5.3 NA	7.8	20.0	Ø21.00	7.8	5.9
	MQD-04	Ø12.40	Ø11.15	Ø6.60	8.38 8.10	5.60 5.25	8.6	20.0	Ø21.00	NA	5.9
	MQD-04-1	NA	Ø11.15	Ø6.60	NA 8.10	NA 5.25	8.6	NA	NA	NA	NA

Table 1b: Socket Dimensional Specification

	Dimension (see Fig 2)	W MQD MQDB	X	Y MQD MQDB	Z	AA	AB	AC	AD	AE	AF	AG
	Tolerance value	±0.1	±0.15	±0.2	Ref	±0.05	±0.1	±0.2	±0.05	±0.05	±0.05	±0.05
SOCKET SIZE	MQD-02	15.40 15.60	Ø 2.6	25.70 25.70	Ø 9.6	Ø 16.85	Ø 1.5	Ø 15.3	Ø 15.2	Ø 15.08	Ø 10.6	1.1
	MQD-03	14.45 14.45	Ø 2.2	25.25 25.25	Ø 11.1	Ø 18.00	Ø 1.5	Ø 16.8	Ø 16.7	Ø 16.58	Ø 12.1	1.1
	MQD-04 MINI	18.3 NA	Ø 2.2	29.1 NA	Ø 14.8	NA	Ø 1.5	Ø 20.4	Ø 20.2	Ø 20.08	Ø 15.6	1.1
	MQD-04	21.80 21.50	NA	31.60 31.30	NA	Ø21.60	Ø 1.5	Ø 20.4	Ø 20.2	Ø 20.08	Ø 15.6	1.1
	MQD-04- 1	NA 21.50	NA	NA 31.30	NA	Ø19.00	Ø 1.6	Ø 17.3	NA	NA	NA	NA

Table 1c: Thread Specification

	Size	Thread
		T1
SOCKET SIZE	MQD-02	SAE. -4 size 7/16-20 UNF 2A
	MQD-03	G1/4-19 BSPP, Custom End
	MQD-04 MINI	G3/8-19 BSPP, Custom End
	MQD-04 & 04-1	G3/8-19 BSPP, Custom End

Table 1d: Socket Dimensional Specification

	Size	B	U1	AV	H2	BA	(BB)
	Tolerance	±0.025	±0.15	±0.5°	+0.0 -0.2	±0.3	Ref
SOCKET SIZE	MQD-02	Ø6.71	11.20	50	15.9	10.6	5.0
	MQD-03	Ø8.90	14.40	50	16.0	11.0	3.2
	MQD-04 MINI	Ø11.15	NA	25	NA	NA	NA
	MQD-04	Ø11.15	17.00	25	19.0	8.9	1.3
	MQD-04-1	Ø11.15	16.17	NA	17.9	8.4	1.1

Table 1e: MQDB Socket Dimensional Specification

	Size	W2	BM	BN	W3	AW	AX
	Tolerance	±0.15	±0.15	±0.15	±0.15	Ref	Ref
SOCKET SIZE	MQD-02	NA	NA	NA	NA	16.60	2.0
	MQD-03	NA	NA	NA	NA	17.00	2.0
	MQD-04 MINI	NA	NA	NA	NA	19.40	2.0
	MQD-04	18.8	4.0	4.46	18.0	19.40	1.7
	MQD-04-1	17.8	4.2	5.74	16.5	NA	NA

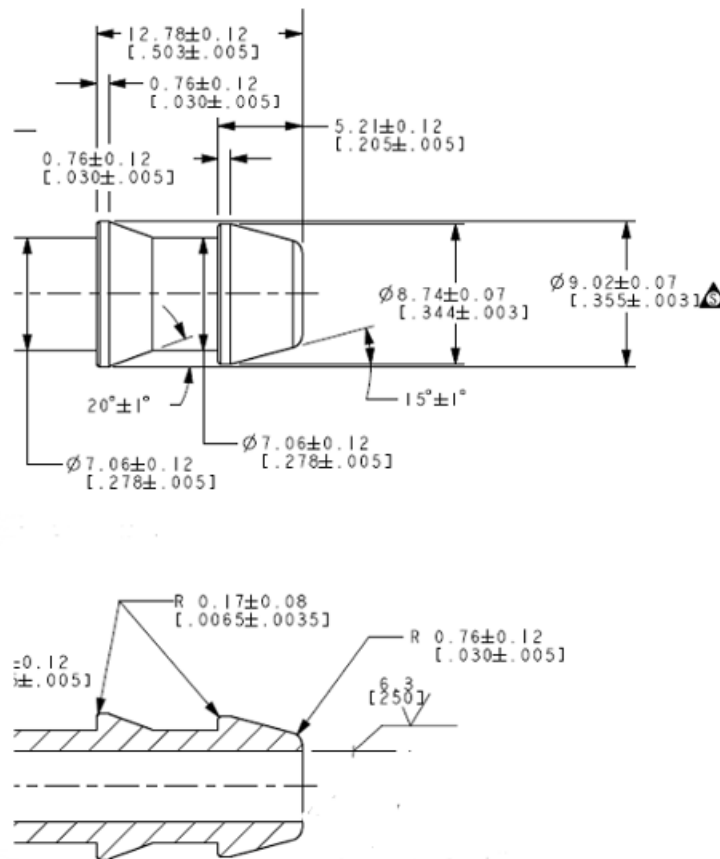
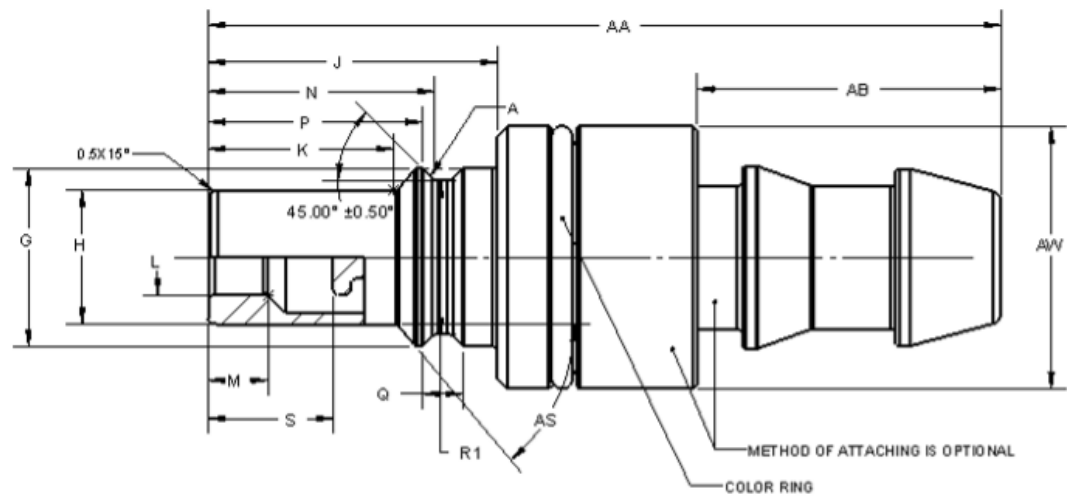


Figure 3a: MQD02/03/04 Plug Dimensions & Hose Barb Geometry Details for Dash Size 04

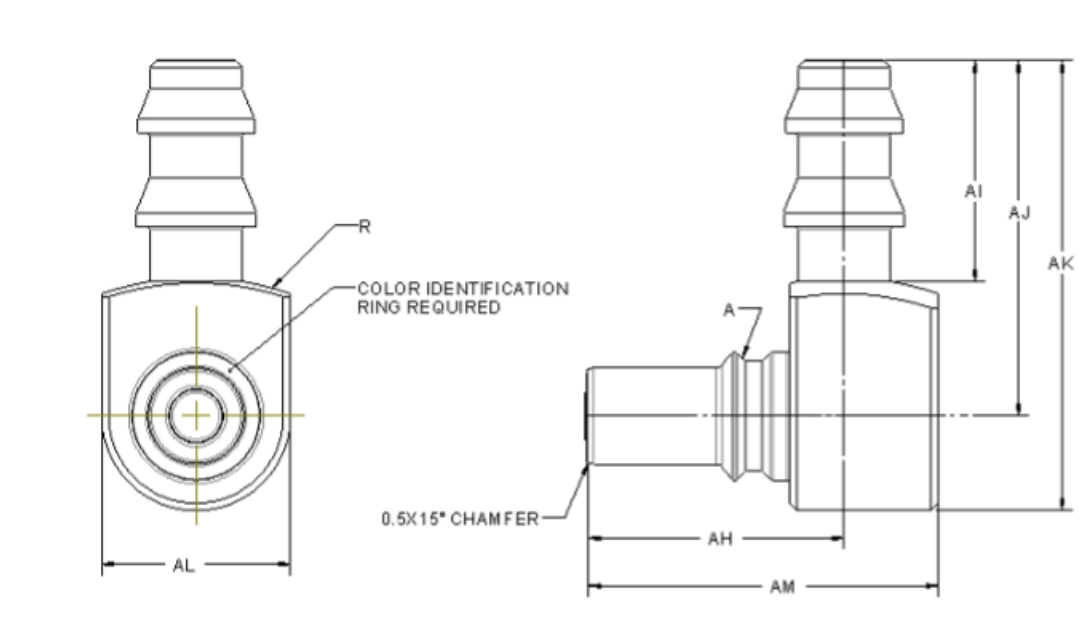


Figure 3b: MQD02 Plug Dimensions

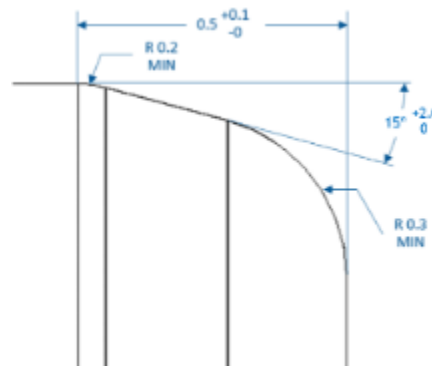


Figure 3c: MQD(B) 02/03/04 Plug body & Socket Piston entry chamfer details

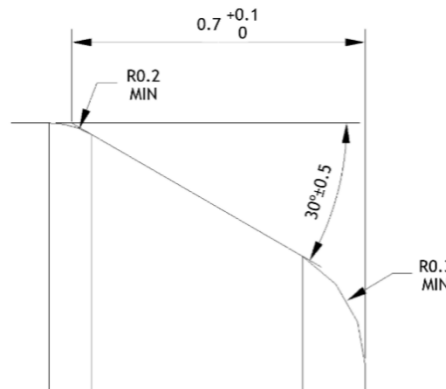


Figure 3d: MQD(B) 04 MINI Plug body & Socket Piston entry chamfer details

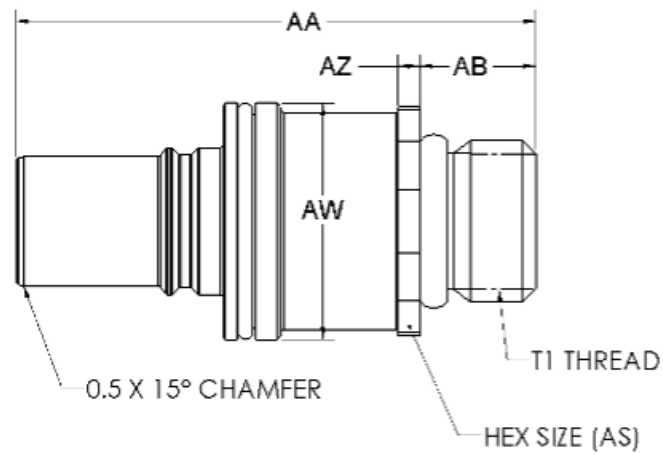


Figure 3e: MQD03/04 Plug Dimensions

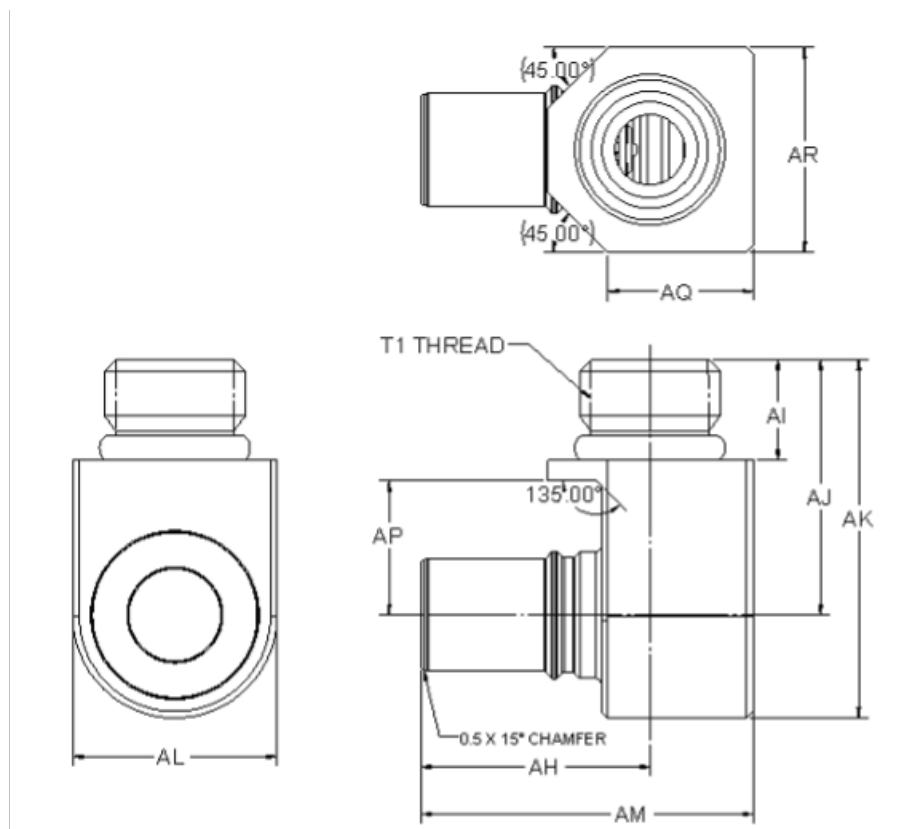


Figure 3f: MQD03 Right Angle Plug Dimensions

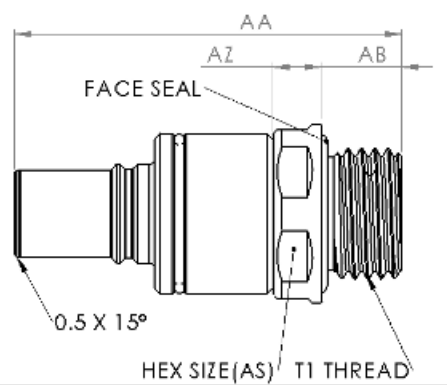


Figure 3g: MQD03 Straight Plug Dimensions

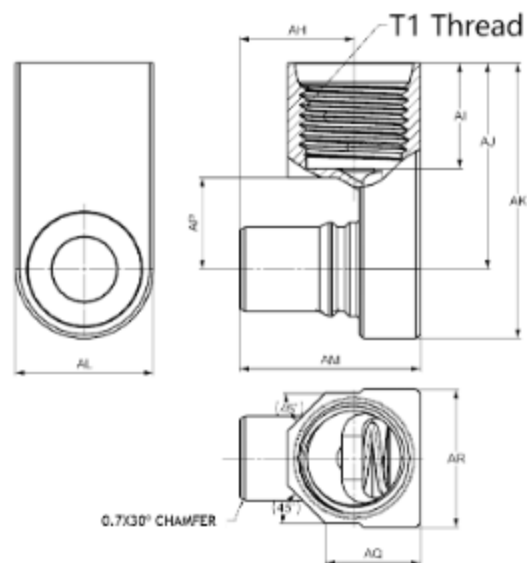


Figure 3h: MQD04 MINI Plug Dimensions

Table 2a: MQD Plug Dimensional Specification (Dimensions are in millimeters)

	Dimensions (Figure 3)	G	H	J	K	L	M	N*	P	Q	R	S
	Tolerance Value	±0.025	±0.025	MIN	±0.05	±0.025	MAX	±0.05	±0.05	±0.20	±0.15 Hose Tail SAE Custom	Nominal
PLUG SIZE	MQD-02	Ø8.80	Ø6.65	14.0	9.35	Ø3.73	2.75	11.10	10.60	2.0	20.0 NA***	7.1
	MQD-03	Ø10.0	Ø8.80	14.1	9.75	Ø5.03	2.75	11.10	10.60	1.80	30.0 NA***	7.4
	MQD-04 MINI	Ø12.3	Ø11.07	15.7	10.45	Ø6.70	3.0	12.73	12.12	2.3	NA NA	7.8
	MQD-04	Ø12.3	Ø11.07	17.5	12.00	Ø6.70	3.0	14.28	13.67	2.3	NA*** NA***	8.6

Table 2b: MQD Plug Dimensional Specification

	Dimensions (Figure 3)	AA Hose Tail SAE Custom BSPP Custom	AB # Hose Tail SAE Custom BSPP Custom	AH Hose Tail SAE Custom BSPP Custom	AI Hose Tail SAE Custom BSPP Custom	AJ Hose Tail SAE Custom BSPP Custom	AK (REF) Hose Tail SAE Custom BSPP Custom	R1*	AW	AS
	Tolerance Value	±0.20	±0.10	±0.20	±0.10	±0.10	±0.20	±0.05	±0.10	±0.5°
PLUG SIZE	MQD-02	39.3 NA NA	15.06 NA NA	17.7 NA NA	15.25 NA NA	24.5 NA NA	31.0 NA NA	7.80	13.0	50
	MQD-03	NA 35.4 39.0	NA 7.9 8.0	17.90 17.90 NA	15.25 8.0 NA	24.0 20.0 NA	32.50 28.05 NA	9.00	16.1	50
	MQD-04 MINI	NA NA NA	NA NA NA	NA 15 NA	NA 13.8 NA	NA 27 NA	NA 36.05 NA	11.07	NA	25
	MQD-04	NA 38.5 NA	NA 8.0 NA	NA 22.1 NA	NA 8.0 NA	NA 22.95 NA	NA 32.0 NA	11.07	18.1	25

Note: Terminal end order and dimension order is the same

Table 2c: MQD Plug Dimensional Specification

	Dimensions	AL** Hose Tail SAE Custom BSPP Custom	AM Hose Tail SAE Custom BSPP Custom	AP Hose Tail SAE Custom BSPP Custom	AQ SAE Custom BSPP Custom	AR SAE Custom BSPP Custom	AS SAE Custom BSPP Custom	AZ SAE Custom BSPP Custom
	Tolerance Value	±0.2	±0.2	±0.1	±0.2	±0.2	+0.0 -0.2	±0.15
PLUG SIZE	MQD-02	13.0 NA NA	24.2 NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA	NA NA NA
	MQD-03	16.1 16.1 NA	26.0 26.0 NA	NA 10.5 NA	11.35 NA NA	16.1 NA NA	15.0 17.0** NA	1.5 5.0 NA
	MQD-04 MINI	NA 18.1 NA	NA 23.7 NA	NA 12 NA	NA 12.45 NA	NA 18.1 NA	NA NA NA	NA NA NA
	MQD-04	NA 18.1 NA	NA 30.75 NA	NA 12.95 NA	12.75 NA NA	18.1 NA NA	16.0 NA NA	1.5 NA NA

++ : Hex width: 2.5 mm & maintain sufficient wall above groove OD of face seal to meet burst pressure mentioned in spec

Table 2d: MQD Terminal End Details

	Size	Terminal end details
		T1 (Refer respective image for reference)
SIZE	MQD-02	Hose barb, 04 size
	MQD-03	SAE (-04 size), 7/16-20 UNF 2A Custom End G 1/4 Custom End
	MQD-04 MINI	SAE-6 ORB, 9/16-18 UNF 2B (FEMALE)
	MQD-04	SAE (-04 size), 7/16-20 UNF 2A

A : In the ball contact surface area, identified in Figure 3 MQD Plug Dimensions, the minimum hardness is 75-95 HRB for parts made from forging blanks and 24HRC minimum for parts made out of bar stock.

* Optional with 45 ° +/- 0.5°

**Forging surface to be machined to improve appearance with smooth edges

*** : Surface in this case is flat with maintaining dimension "AI"

: Optional details of hose barb details. If not used supplier must meet performance criteria mentioned in table 10 to table 12 for respective size.

Recommended extrusion gap is 0.05 mm at nominal between plug valve and plug body and socket valve and socket body and socket piston and socket body sealing diameter. See 3D model

Terminal end of each variant are mentioned in same order as dimension

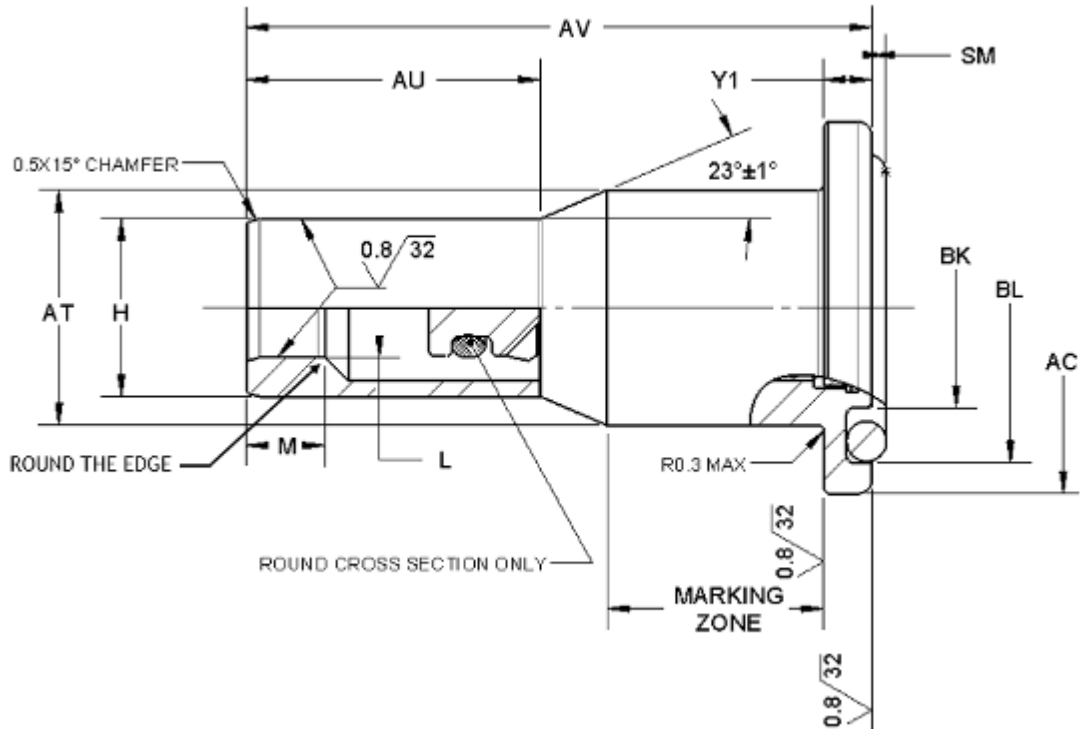


Figure 4a: MQDB02 Plug Dimensions

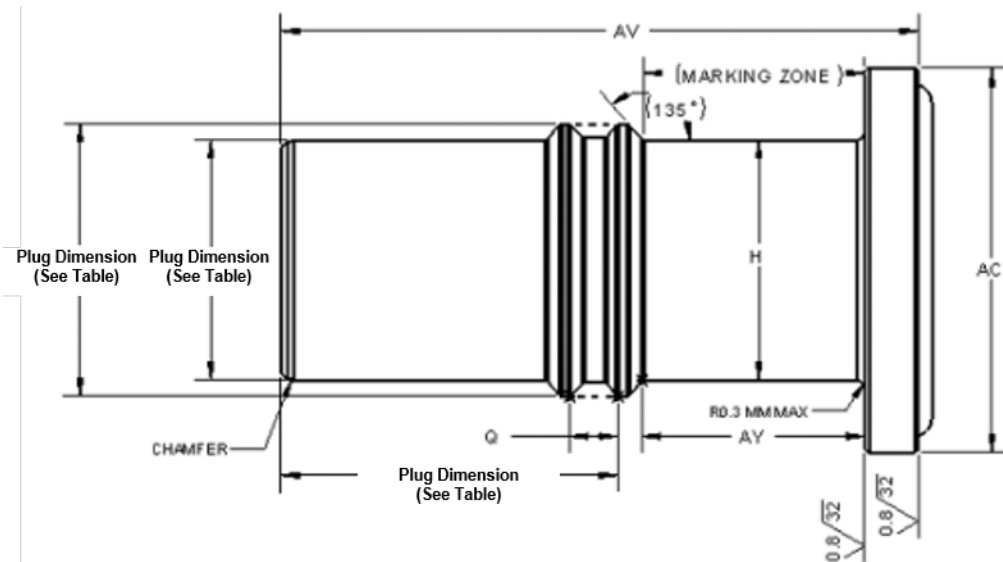


Figure 4b: MQDB03 & 04 & 04 MINI Plug Dimensions (Hybrid Design)

Table 2e: MQDB Plug Dimensional Specification (Dimensions in millimeters)

	Size	H	L	AV	Y1	SM*	BK	BL
	Tolerance Value	±0.025	±0.025	±0.1	±0.03	±0.06	Min	Max
PLUG SIZE	MQD-02	Ø6.65	Ø3.73	23.4	1.80	0.25	Ø 8.85	Ø 12.75
	MQD-03	Ø8.80	Ø5.03	23.23	1.80	0.25	Ø 9.25	Ø 13.15
	MQD-04 MINI	Ø11.07	Ø6.70	27.1	2.70	0.25	Ø 11.15	Ø 15.05
	MQD-04	Ø11.07	Ø6.70	28.6	2.70	0.25	Ø 11.15	Ø 15.05

Table 2f: MQDB Plug Dimensional Specification

	Size	AU	AT	AC	AY
	Tolerance Value	±0.05	±0.025	±0.05	REF
PLUG SIZE	MQD-02	11.0	Ø 8.80	Ø 13.90	NA
	MQD-03	NA	NA	Ø 14.10	8.00
	MQD-04 MINI	NA	NA	Ø 16.10	8.60
	MQD-04	NA	NA	Ø 16.10	8.60

4.2. MQDB Engagement

Plug and socket pairs shall meet Cv and Flow rating and performance requirements with insertion tolerance given in the table below.

Table 3: MQDB Engagement

Size	Nominal Engagement Stroke (mm)	Min Engagement* (mm)
MQD-02	7.1	6.1
MQD-03	7.4	6.4
MQD-04 MINI	7.8	7.6
MQD-04	8.6	7.6

Only minimum engagement is considered. Assumption is that valve will be maximum area at nominal engagement and will not decrease for any further insertion beyond nominal prior to and including the hard stop position. Therefore, there is no specified tolerance for max engagement.

4.3. MQDB Coupling Insertion Panel to Panel Distance

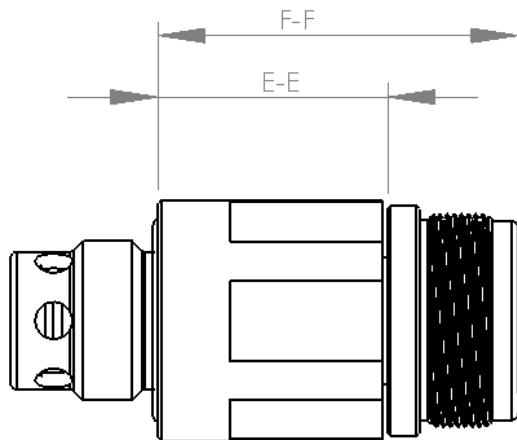


Figure 5: MQDB Coupling Panel to Panel Distance

Table 4: MQDB Panel to Panel Distance

Size	E-E Nominal Panel to Panel Distance (mm)	Length F-F (mm)
MQD-02	7.1	6.1
MQD-03	7.4	6.4
MQD-04 MINI	7.8	7.6
MQD-04	8.6	7.6

4.4. Terminations

Termination options are left to the discretion of the manufacturer. Terminations shown in table 5 shall be available in the size described by the manufacturer.

Table 5: MQD Terminations

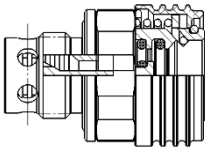
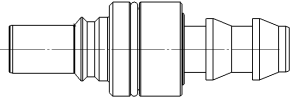
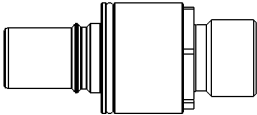
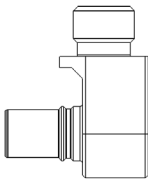
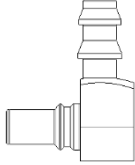
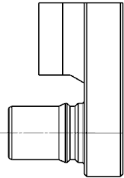
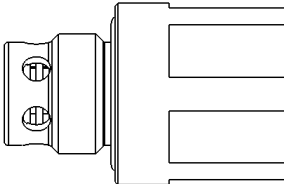
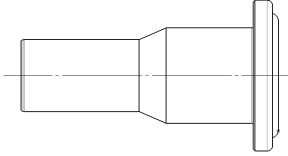
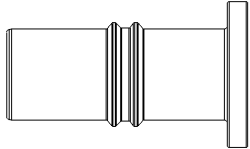
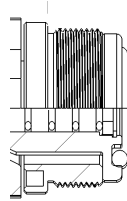
		    
Size	Socket (Custom Profile: Reduced thread length & face sealing)	Plug (Custom end: Reduced thread length)
MQD-02	Straight, SAE -4 ORB and custom profile	1. Straight, Barb to mate with 1/4" reinforced EPDM hose 2. Elbow, Barb to mate with 1/4" reinforced EPDM hose
MQD-03	Straight BSPP, G1/4-19 and custom profile	1. Straight, SAE -04 ORB custom end 2. Elbow, SAE -04 ORB end 3. G 1/4 BSPP custom end
MQD-04 MINI	Straight BSPP, G3/8-19 and custom profile	1. Elbow, SAE -06 ORB (FEMALE)
MQD-04	Straight BSPP, G3/8-19 and custom profile	1. Straight, SAE -04 ORB custom end 2. Elbow, SAE -04 ORB custom end

Table 6: MQDB Terminations

		   (Method of attaching floating body)
Size	Socket (Custom Profile: Reduced thread length & face sealing)	Plug
MQDB-02	Straight, SAE -4 custom end	Straight, floating plug body. *Nut not included in assembly of floating plug. *Nut to be arranged separately by end user
MQDB-03	Straight BSPP, G1/4-19 and custom profile	Straight, floating plug body. *Nut not included in assembly of floating plug. *Nut to be arranged separately by end user
MQDB-04 MINI MQDB-04-1	Straight BSPP, G3/8-19 and custom profile	Straight, floating plug body. *Nut not included in assembly of floating plug. *Nut to be arranged separately by end user

Terminations shall meet the operating and burst pressure performance requirements specified in this document.

4.5. Latching Requirements

The socket shall include a mechanism that latches and locks the socket to the plug in the area identified in Figure 3 MQD Plug Dimensions bounded by dimensions. This locking mechanism must be utilized to meet the pressure and durability requirements

specified in this document in its coupled state. The mechanism shall be housed in the socket body and must be a roller pin design as shown in image.

5. Performance and Testing Requirements

The following section defines the physical design requirements and performance metrics of the quick disconnects.

5.1. Key Performance Indicators

The following Key Performance Indicators (KPI's) are measured parameters that are key in defining the appropriate part selection. Suppliers should have data available to address the KPI's below:

1. Flow Rating
2. Temperature Rating
3. Pressure Rating
4. Burst Pressure Rating
5. Fluid loss on disconnect
6. C_v (Flow Coefficient)
7. Force to connect
8. Force to disconnect (only for MQD, vendor documented)
9. Spillage
10. Air inclusion

5.2. Performance Requirements

The coupling shall meet or exceed the performance requirements listed in Table 3.

Table 7: Performance Requirements

			MQD Size			
Parameter	Test(s)	Units	02	03	04 MINI	04
Maximum Operating Pressure	-	bar(g)	6.89			
		psi(g)	100			
Minimum Proof Pressure	5.3.1	bar(g)	20.68			
		psi(g)	300			
Minimum Cv	5.3.4	-	0.3	0.6	0.8	1.0
Minimum Flow Rating	-	L/min	2.08	4.54	6.81	6.81
		GPM	0.55	1.2	1.8	1.8
Maximum Force to Connect (MQDB Only)	5.3.3	N	53.38	57.83	62.28	62.28
		lbf	12	13	14	14
Maximum Force to disconnect (Max)		N	53.38			
Allowable Radial Offset (MQDB Only)		mm	+/- 1			
Connection Cycles	5.4.3	-	5000			
Maximum Fluid Loss per Cycle	5.3.2	mL	0.020	0.023	0.025	0.025
Shipping Temperature Range	5.4.1	°C	-40 to 75			
Operating Temperature Range	5.4.2	°C	17 to 65			
Storage Life	-	-	5 Years			
Service Life	-	-	10 Years			

5.3. Validation Test Requirements

The following tests in this section are reflective of the requirements in Table 3 in the previous section. The tests are broken down into the following groups:

1. MQD Property Tests
2. Thermal / Mechanical Cycling Tests

Time Zero QD property & mechanical cycling tests can be run in parallel using different samples for each test. Thermal Tests must be run sequentially with the same set of samples. Separate set of samples may be used for connected and disconnected stage. An overview of both groups of tests can be seen in Figures 5 and 6.



Figure 6: MQD Property Tests

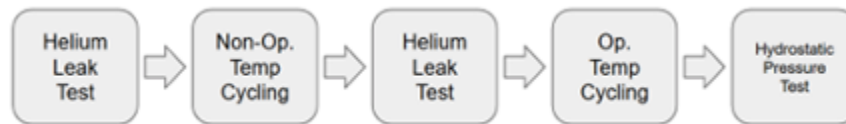


Figure 7: MQD Cycling Tests

Each test shall be conducted and the test data collated in a test report. Upon completion, the test report shall be available for the end user for review.

All helium leak tests conducted shall be in accordance with ASTM E493.

In accordance with ISO 18869, the **required sample size per test is 5, at minimum**. In accordance with ISO 18869:2017 Section 6.3, the instruments must meet certain accuracy requirements.

5.3.1. Burst Pressure

Test Description	Conduct a burst pressure test on the plug, socket, and mated pair.
Test Position	Fully mated (MQD/MQDB pair) and disconnected (plug/socket).
Test Pressure	Test to failure, or pressure 3x minimum proof pressure – whichever is lower
Specific to MBQD	Test shall be conducted at the fully mated, hard-stop condition.
Acceptance Criteria	Burst pressure is above Minimum Proof Pressure (Table 3)

5.3.2. Fluid Loss

Test Description	Conduct the test according to ISO 18869:2017 Section 12 Additional requirements: Conduct Test at 0psi, 16.5psi, and 72psi. Disengagement speed: 20mm/s (fast), 10mm/s (slow).				
Test Fluid	Water				
Acceptance Criteria			0 psi	16.5 psi	72 psi
	MQD(B)-02	20mm/sec			
		10mm/sec			
	MQD(B)-03	20mm/sec			
		10mm/sec			
	MQD(B)-04	20mm/sec			
		10mm/sec			

5.3.3. Force to Connect

It is recommended to minimize coupling and decoupling forces for both MQD and MQDB applications. In addition, latching mechanisms shall provide visual, tactile, and or audible feedback to users. MQD pairs shall lock together in the coupled condition.

Test Description	Conduct the test according to ISO 18869:2017 Section 7. Repeat the test for a total of five times per sample. Use the maximum force found per test and average the results from all the tests and all the samples to determine the connect force. Report the average (of the maximums) in the test report. Unless otherwise requested, the test shall be conducted while fully aligned radially and angularly.
Test Temperature	Ambient
Test Pressures	Conduct the test at 3 pressure levels: 0/2.76/6.89 bar(g) (0/40/100 psi(g)).
Test Fluid	Air or water
Connection Speed	40 mm/s
Acceptance Criteria	For information only

Specific to MQDB

Max coupling force at 1 bar(g) (0 psi(g)) must be less than required in Table 7: Performance Requirements Maximum Force to Connect (MQDB Only)
Conduct the test at maximum radial misalignment, resetting the misalignment to maximum after each cycle.

5.3.4. Pressure Drop

Test Description	
Conduct the test according to ISO 18869:2017, Section 13 except as indicated below. The test apparatus shall use hose or tubing with nominal inside diameter. The connections to the QD shall be made with minimal adapter fittings, example as shown in the image below. This image represents the section from L2 through L4 of ISO 18869:2017 diagram. ISO 18869:2017, Section 13.3 – Remove the test coupling from the test apparatus and connect the tubes or hoses using a connector per the images below. All hose, tubing, or fittings connected between pressure taps (2) and coupling under test (1) shall be the same in test and tare setup. ISO 18869:2017, Section 13.4 – Test fluid used shall be 25% propylene glycol and 75% water, with or without additives, and the test shall be performed at approximately 25±5°C. ISO 18869:2017, Section 13.5 – Subtract the pressure drop values collected in section 13.3 from those collected in 13.2. Graphically plot the net pressure drop for each flow direction. Calculate the best fit polynomial and report the curve fit equation for the average pressure drop (n=5 minimum) in each flow direction as well as pressure drop at 100% and 150% of rated flow. ISO 18869:2017, Section 13.6 – Report pressure drop in both flow directions: plug-to-socket and socket-to-plug.	
Test Temperature	25±5°C
Test Fluid	PG25
Test Flowrates	The 100% rated flowrate is defined by the Flow Rating parameter according to the MQD/ MQDB specifications. Per MQD/ MQDB specs, 100% rated flowrate is MQD/ MQDB-02: 2.08 L/min (0.55 GPM), MQD/ MQDB-03: 4.54 L/min (1.2 GPM), MQD-04 MINI: 6.81 L/min (1.8 GPM), MQD/ MQDB-04: 6.81 L/min (1.8 GPM). Select at least six flow rates from 25 % to 150 % of the rated flow, including 100 % of rated flow.
Specific to MQDB	Cv value should be reported at minimum engagement distance: MQDB-02: 6.1mm, MQDB-03: 6.4mm, MQDB-04: 7.6 mm

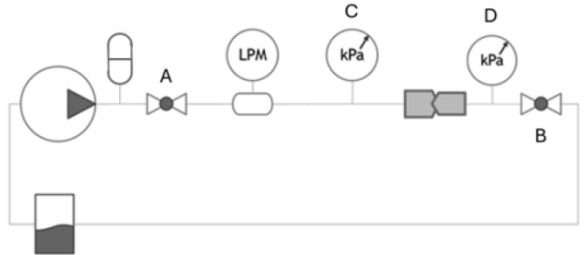
Acceptance Criteria	Per MQD specs for MQD/MQDB, minimum Cv at minimum engagement is: MQD/MQDB-02: 0.3, MQD/MQDB-03: 0.6, MQD-04 MINI: 0.8, MQD/MQDB-04: 1.0
Reported Value	Pressure drop vs. flowrate should be reported using a best fit line with an equation of the form: $dP(Q)=A \cdot Q^2+B \cdot Q$. Report the coefficients A and B when using the units [L/min] for flowrate and [psi] for pressure. Coefficients for different units may be provided as supplementary information.

5.3.5. Seal Washout (Closed Loop)

The Seal Washout test is conducted to ensure that the seal geometry of the QD can withstand connection / disconnection under high pressure / flowrate conditions without washing the plug / socket valve seal out of its gland, creating a leak. This test is meant to recreate the real world scenario of connecting / disconnecting a filled server into a filled TCS loop.

For guidance on use in an open loop scenario, such as during filling or draining a server – contact QD supplier for guidance. In an open loop scenario, extreme pressure drop and line velocity across a UQD valve set can induce a seal washout event. As such, fill and drain practices should follow a progressive introduction of flow and pressure within ratings.

Test Description	Test Setup: Using a test setup similar to the below diagram, conduct the following: 1. With circulator off and couplings fully connected, charge the system test pressure. 2. With valve B completely open, turn circulator on and adjust valve A to achieve test flow rate. 3. Disconnect the coupling with circulator running and record the pressure values of gauges C and D. The differential pressure between these two gages should align with expected dP across part under test. Test Process: 1. With QD disconnected and circulator off, verify static pressure is at test pressure 2. With QD connected and circulator on, check flow is at the test flow rate 3. Turn circulator on and conduct testing by connecting and disconnecting the coupling half according to the number of cycle specified, at the specified rate. Removing or overriding the locking mechanism of the handmate configuration is acceptable. 4. Observe for failure (leakage and/or seal dislodged from valve) until the number of cycles is achieved 5. If no failure is observed in steps 1-4, then reverse the flow direction and repeat steps 1-4
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	 Seal Washout (Closed Loop) Diagram
Number of Cycles	20, each direction (plug to socket / socket to plug)
Test Flowrate	Level I 2.0x the Maximum Flow Rating for the QD (Reference Test Flow Rates from 5.3.4) Level II 1.8x the Maximum Flow Rating for the QD (Reference Test Flow Rates from 5.3.4) Level III 1.6x the Maximum Flow Rating for the QD (Reference Test Flow Rates from 5.3.4)
Test Temperature	60°C
Test Pressure	5.0 bar(g) 72.0 psi(g)
Test Fluid	Water or PG25
Connection Speed	40mm/s $\pm$ 10mm/s
Acceptance Criteria	No leakage or seal washout.

5.4. Thermal / Mechanical Cycling Tests

5.4.1. Non-Operational Temperature Cycling

Test Description	Helium leak test each sample before cycling tests. Conduct a thermal cycling test with air. After testing, conduct helium leak tests on all samples.
Test Position	Connected with nominal engagement (MQD/MQDB) and disconnected (plug/socket)
Test Temperature	-40°C for 72H and +75°C for 72H and back to room temperature
Temperature Transition Rate	10°C/min
Test Fluid	Air
Specific to MQDB	Test should be conducted at the fully mated, hard-stop condition.
Acceptance Criteria	No visible leakage. After testing, helium leak rate $\leq 1 \times 10^{-5}$ mbar-L/s.

5.4.2. Operational Temperature Cycling

Test Description	Conduct a hydrostatic pressure test at 6.9 bar(g) (100 psi(g)) on each sample before the test. Conduct a thermal cycling test with the test fluid. After testing, conduct a hydrostatic pressure test.
Test Position	Connected with nominal engagement (MQD/MQDB) and disconnected (plug/socket).
Test Temperature	17°C for 72H and +65°C for 72H and back to room temperature
Temperature Transition Rate	10°C/min
Test Pressure	6.9 bar(g) (100 psi(g)) at test temperature
Test Fluid	Water or PG25
Acceptance Criteria	No visible leakage. After testing, conduct a hydrostatic pressure test at 6.9 bar(g) (100 psi(g))

5.4.3. Mechanical Cycling

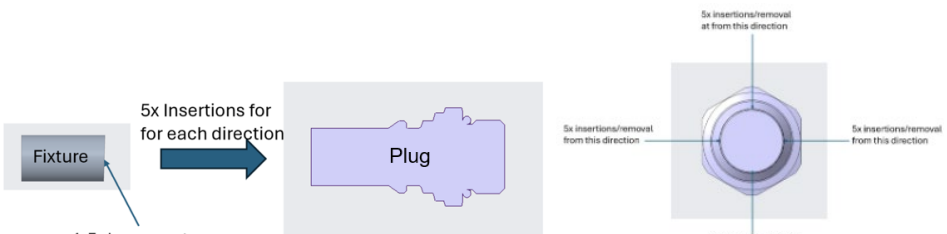
Test Description	Cycle the MQD/MQDB. For MQD, the latch must be actuated each cycle. After testing, conduct a hydrostatic pressure test.
Number of Cycles	5000
Connection Speed	40 mm/s
Test Temperature	38 °C
Test Pressure	2.75 bar(g) (40 psi(g))
Test Fluid	Water or PG25
Acceptance Criteria	After testing, no visible leakage. After testing, conduct a hydrostatic pressure test at 6.9 bar(g) (100 psi(g)).
Specific to MQDB	Each cycle shall be conducted at the maximum radial misalignment. The MQDB plug shall be reset to its maximum radial misalignment after each cycle.

5.4.4. Pressure Impulse Test

Test Description	Conduct the test according to ISO 18869:2017 Section 19
Test Position	Connected with nominal engagement (MQD/MQDB) and disconnected (plug/socket)
Number of Cycles	5000

Test Temperature	65 °C
Test Pressure	0 to 9.2 bar(g) (0 to 133 psi(g))
Test Fluid	Water
Frequency	0.1 to 0.5 Hz
Acceptance Criteria	No visible leakage during test

5.4.5. Valve Tilting Test

Test Description	To evaluate MQD plug and socket sealing ring does not get stuck
Test Sample	MQD/MQDB plug & socket (protective cap removed) – 5x random samples for plug/socket
Test Procedure	1. Socket Check: Insert fixture with 1.5 degree cut with into socket 5 times with minimum 6mm insertion travel. Do this at 4 different points of entry: 0-degree, 90-degree, 180-degree, and 270-degree by rotating the fixture  2. Plug Check: Insert fixture with 1.5 degree cut with into plug 5 times with minimum 6mm insertion travel. Do this at 4 different points of entry: 0-degree, 90-degree, 180-degree, and 270-degree by rotating the fixture 

6. Supplier Cross-Validation Testing

For blind mate application, a floating block or mechanism should be used in conjunction with a MQD plug to blind mate with a MQDB socket. The floating fixture should be created by system designer using the MQDB plug and use for this test.



Figure 8: Example MQD Floating Fixture

Suppliers shall cross-validate their parts with a minimum of 3 other suppliers. MQD suppliers shall make their QDs available to other MQD suppliers upon request for cross-validation purposes. Likewise, the requesting supplier shall make available their QDs at the time of request. MQD Suppliers shall publish the supplier list with which their QDs have successfully passed cross-validation testing. The cross-validation test reports shall be submitted to end users for review and approval.

The required cross-validation tests, shown in Figure 6, are a subset of the QD Property Tests. These tests are considered critical to ensuring the interoperation of one supplier's QDs with those of a different supplier. The tests may be run in parallel or series for property test and sequentially for thermal cycling test. Separate set of samples can be used for connected and disconnected stage. In accordance with ISO 18869, the **required sample size per test is 5, at minimum**. In accordance with ISO 18869:2017 Section 6.3, the instruments must meet certain accuracy requirements

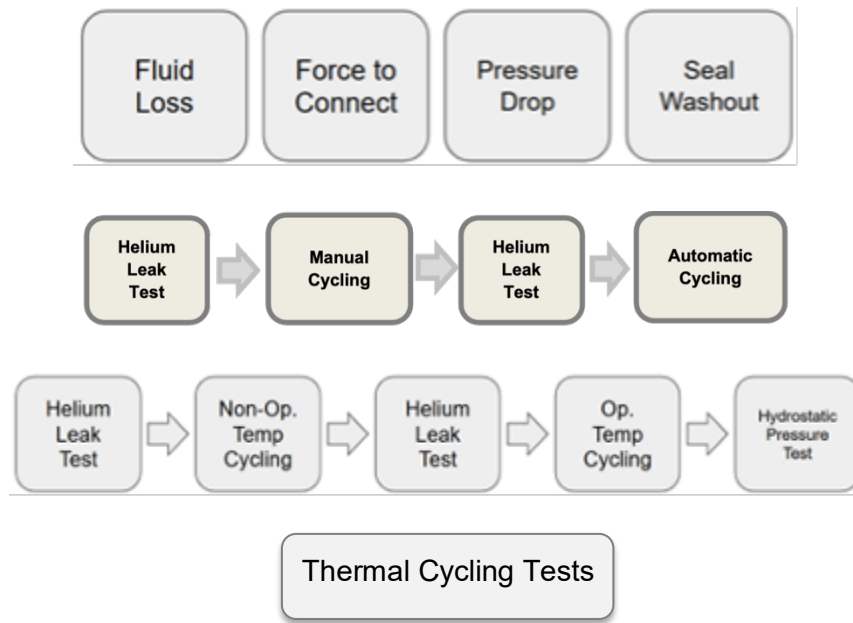


Figure 9: Cross Validation Tests

The MQD/ MQDB tests shall be conducted in the following configurations with the results for both all sets of tests included in the test report:

1. Using the potential supplier's MQD plug and MQD sockets from other suppliers
2. Using the potential supplier's MQD socket and the MQD plugs from other suppliers
3. Using the potential supplier's MQD plug, system MQD Floating fixture, and MQDB sockets from other suppliers
4. Using the potential supplier's MQDB socket, MQD plugs from other suppliers, and system MQD Floating fixture.

6.1. MQD Property Tests

Tests in this section shall be conducted with at least 2 samples (for each test) from each vendor. The tests do not need to be in any specific order. To reduce the number of samples needed from the vendor, the tests should be conducted sequentially using the same sample pair for the subsequent tests.

6.1.1. Burst Pressure

Conduct this test according to Section 5.3.1

6.2.1. Fluid Loss

Conduct this test according to Section 5.3.2

6.1.3. Force to Connect

Conduct this test according to Section 5.3.3

6.1.4. Pressure Drop (Cv)

Conduct this test according to Section 5.3.4

6.1.5. Seal Washout

Conduct this test according to Section 5.3.5

6.2. Cycle Testing

The tests in this section shall be conducted with at least 3 samples (for each test) from each vendor.

6.2.1. MQD Cycle Testing

6.2.1.1. Manual Cycling

Test Description	Helium leak test each sample before the cycle tests. Conduct manual cycle testing on the MQD pair. The latch must be actuated on each cycle. After testing, drain and dry the samples and then conduct a helium leak test on all samples.
Number of Cycles	50
Test Pressure	2.75 bar(g) (40 psi(g))
Test Fluid	Water
Acceptance Criteria	Before and after cycle tests, helium leak rate $\leq 1 \times 10^{-5}$ mbar-L/s

6.2.1.2. Automated Cycling

Test Description	Helium leak test each sample before the cycle tests. Conduct automated cycle testing on the MQD pair. The latch must be actuated each cycle. After testing, drain and dry the samples and then conduct a helium leak test on all samples.
Number of Cycles	5000
Test Pressure	2.75 bar(g) (40 psi(g))
Test Fluid	Water
Connection Speed	40 mm/s
Acceptance Criteria	Before and after cycle tests, helium leak rate $\leq 1 \times 10^{-5}$ mbar-L/s

6.2.2. MQDB Cycle Testing

6.2.2.1. Automated Cycling

As a reminder, this test shall be conducted in the following configurations with the results for both sets of tests included in the test report:

1. Using the potential supplier's MQD plug, MQD Floating fixture, as well as MQDB sockets from the vendor.
2. Using the potential supplier's MQDB socket, MQD plugs from the vendor, and MQD Floating fixture.

Test Description	Helium leak test each sample before the cycle tests. MQDB Cycle Testing consists of 5000 total cycles. The first 2500 cycles shall be conducted with a radial offset applied during each cycle. After the first 2500 cycles, drain and dry the samples and then conduct a helium leak test on all samples. The next 2500 cycles shall be conducted with an angular offset. After testing, drain and dry the samples and then conduct a helium leak test on all samples.
Number of Cycles	2500 cycles with a 2mm radial offset applied to the plug after each cycle 2500 cycles with a 1.5° angular offset
Test Pressure	2.75 bar(g) (40 psi(g))
Test Fluid	water
Connection Speed	40 mm/s
Acceptance Criteria	Before and after cycle tests, helium leak rate $\leq 1 \times 10^{-5}$ mbar-L/s

6.3. Thermal Cycling

The tests in this section shall be conducted using the potential supplier's MQD plug, MQD Floating Mechanism, as well as MQDB sockets from the vendor

6.3.1. Non-Operational Temperature Cycling

Test Description	Helium leak test each sample pair in the connected position before the thermal cycling tests. Conduct a thermal cycling test with air. After testing, conduct a helium leak test on all samples.
Test Position	Connected with nominal engagement
Test Temperature	-40°C for 72H and +75°C for 72H and back to room temperature
Temperature Transition Rate	10°C/min
Test Fluid	Air
Acceptance Criteria	No visible leakage. After testing, helium leak rate $\leq 1 \times 10^{-5}$ mbar-L/s

6.3.2. Operational Temperature Cycling

Test Description	Conduct a thermal cycling test with water. After testing, drain and dry the samples and then conduct a helium leak tests on all sample pairs in the connected position.
Test Position	Connected with nominal engagement
Test Temperature	17°C for 72H and +65°C for 72H and back to room temperature
Temperature Transition Rate	10°C/min
Test Pressure	6.9 bar(g) (100 psi(g))
Test Fluid	Water
Acceptance Criteria	No visible leakage. After testing, helium leak rate $\leq 1 \times 10^{-5}$ mbar-L/s

7. Additional Test Requirements

7.1. O-Ring Property Test

Test Description	To assess how immersion in PG-25 affects the physical properties of O-rings per procedure outline in ASTM D471
Sample Preparation	O-rings are cleaned and measured for initial properties: volume, hardness, tensile, and elongation
Test Process	Immerse O-rings (quantity of at least three) in PG-25 heated to 65°C for a minimum of 6 weeks
Test Fluid	Select an OAT PG-25 fluid
Acceptance Criteria	O-ring material properties after 6 weeks of immersion: • Volume change: -5%/+10% • Hardness change: -10/+10 durometer • Tensile change: up to -20% • Elongation change: up to 25% Submit used coolant for composition analysis according to ASTM D471 Section 9.2

7.2. PG25 Property Test

Test Description	Post 9.1 O-ring Property Test, used PG25 must be tested for chemical composition to verify contamination																																																																						
Test Process	Used PG25 to have fluid analysis performed																																																																						
Test Fluid	Used PG25 From 9.1																																																																						
Acceptance Criteria	<table border="1"> <thead> <tr> <th>Test</th><th colspan="3">Pass criteria using Recochem OAT PG-25</th></tr> <tr> <th></th><th>Acceptable range</th><th>Units</th><th>Minimum Equipment detection sensitivity</th></tr> </thead> <tbody> <tr> <td>pH</td><td>7.2<pH<9</td><td></td><td></td></tr> <tr> <td>Fe</td><td><5</td><td>ppm</td><td>0.1 ppm</td></tr> <tr> <td>Cu</td><td><5</td><td>ppm</td><td>0.1 ppm</td></tr> <tr> <td>Al</td><td><5</td><td>ppm</td><td>0.1 ppm</td></tr> <tr> <td>Zn</td><td><5</td><td>ppm</td><td>0.1 ppm</td></tr> <tr> <td>Ni</td><td><0.1</td><td>ppm</td><td>0.1 ppm</td></tr> <tr> <td>Mg</td><td><10</td><td>ppm</td><td>0.1 ppm</td></tr> <tr> <td>Ca</td><td><5</td><td>ppm</td><td>0.1 ppm</td></tr> <tr> <td>Si</td><td><10</td><td>ppm</td><td>0.1 ppm</td></tr> <tr> <td>Sulfate</td><td><100</td><td></td><td></td></tr> <tr> <td>Nitrogen Oxides (NOx)</td><td>Non detected</td><td></td><td></td></tr> <tr> <td>Chloride</td><td><25</td><td>ppm</td><td>1 ppm</td></tr> <tr> <td>Total Suspended Solids (TSS)</td><td>Non detected</td><td></td><td></td></tr> <tr> <td>Total Dissolved Solids (TDS)</td><td>Non detected</td><td></td><td></td></tr> <tr> <td>Turbidity</td><td>1></td><td>NTU</td><td>NTU</td></tr> </tbody> </table>			Test	Pass criteria using Recochem OAT PG-25				Acceptable range	Units	Minimum Equipment detection sensitivity	pH	7.2<pH<9			Fe	<5	ppm	0.1 ppm	Cu	<5	ppm	0.1 ppm	Al	<5	ppm	0.1 ppm	Zn	<5	ppm	0.1 ppm	Ni	<0.1	ppm	0.1 ppm	Mg	<10	ppm	0.1 ppm	Ca	<5	ppm	0.1 ppm	Si	<10	ppm	0.1 ppm	Sulfate	<100			Nitrogen Oxides (NOx)	Non detected			Chloride	<25	ppm	1 ppm	Total Suspended Solids (TSS)	Non detected			Total Dissolved Solids (TDS)	Non detected			Turbidity	1>	NTU	NTU
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pH	7.2<pH<9																																																																						
Fe	<5	ppm	0.1 ppm																																																																				
Cu	<5	ppm	0.1 ppm																																																																				
Al	<5	ppm	0.1 ppm																																																																				
Zn	<5	ppm	0.1 ppm																																																																				
Ni	<0.1	ppm	0.1 ppm																																																																				
Mg	<10	ppm	0.1 ppm																																																																				
Ca	<5	ppm	0.1 ppm																																																																				
Si	<10	ppm	0.1 ppm																																																																				
Sulfate	<100																																																																						
Nitrogen Oxides (NOx)	Non detected																																																																						
Chloride	<25	ppm	1 ppm																																																																				
Total Suspended Solids (TSS)	Non detected																																																																						
Total Dissolved Solids (TDS)	Non detected																																																																						
Turbidity	1>	NTU	NTU																																																																				

7.3. X-Section Check

Test Description	Inspect cross section for anomaly, deformation, or damages of internal structure
Test Process	Provide cross section image of MQD/B
Acceptance Criteria	Reference check only

7.4. Drop Test

Test Description	To evaluate MQD's resistance to drop shock without causing dis-assembly
Test Sample	MQD/MQDB plug & socket (protective cap removed)
Drop Sequence	Drop 5 times and random orientation
Drop Height	Drop from 3ft height
Drop Surface	Hard flat plywood surface
Acceptance Criteria	MQDs must survive 5 drops with all internal components intact. Internal components cannot be displaced from the original assembled position. Cosmetic physical damage/deformation are OK. Example of failed condition: 

8. Additional Testing Details

8.1. Instrument Accuracy Table

Parameter	Device Name	Units	Measurement Range	Data Accuracy (percentage of maximum measured value)
Flow rate		L/min		
Force		N		
Pressure and pressure drop		Bar(g) /psi(g)		
Volume (leakage)		mL		
Temp		°C		

8.2. Helium Leak Rate Unit Conversion

	Pa-m ³ /s	mbar-L/s	N-cm ³ /s	sccm
1 Pa-m ³ /s =	1	10	10	592
1 mbar-L/s =	0.1	1	1	59.2
1 N-cm ³ /s =	0.1	1	1	59.2
1 sccm =	0.001689	0.01689189	0.01689189	1

8.3. Supplier Validation Report Template

Quick Disconnect Validation Report Checklist					
MQD Supplier					
QD Type (Plug & Socket)					
Mechanical Spec		MQD / MQDB			
Test Spec		MQD / MQDB			
Supplier Validation Tests					
Test #	Test Type	Unit of Measure	Specification	Result	Notes
6.1.1.	Burst Pressure				
6.1.2.	Fluid Loss				
6.1.3.	Force to Connect				
	Force to Disconnect				
6.1.4.	Pressure Drop				
6.1.5.	Seal Washout - Operational Test				
6.3.1.	Non-Operational Temperature Cycling				
6.3.2.	Operational Temperature Cycling				
5.4.3.	Mechanical Cycling				
5.4.4.	Pressure Impulse Test				
5.4.5.	Valve Tilting Test				
7.1.	O-ring Property Test				
7.2.	PG-25 Property Test				
7.3.	X-Section Check				
7.4.	Drop Test				

8.4. Supplier Cross-Validation Report Template

Supplier Cross-Validation Report Checklist					
Main MQD Supplier					
Cross-Validation QD Supplier					
QD Type (Plug & Socket)					
Mechanical Spec		MQD / MQDB			
Test Spec		MQD / MQDB			
Supplier Cross-Validation Tests					
Test #	Test Type	Unit of Measure	Specification	Result	Notes
6.1.1.	Force to Connect				
	Force to Disconnect				
6.1.2.	Fluid Loss				
6.1.3.	Burst Pressure				
6.1.4.	Pressure Drop (Cv)				
6.1.5.	Seal Washout				
6.2.1.1.	MQD Manual Cycle Testing				
6.2.1.2.	MQD Automated Cycle Testing				
6.2.2.1.	MQDB Automated Cycle Testing				
6.3.1.	Non-Operational Temperature Cycling				
6.3.2.	Operational Temperature Cycling				