Product Specification for a Water Cooled Gate Valve for the MATERIAL PLASMA EXPOSURE EXPERIMENT (MPEX)

Prepared by

OAK RIDGE NATIONAL LABORATORY
Oak Ridge, TN 37831-6283

Managed by

UT-BATTELLE, LLC

For the

US DEPARTMENT OF ENERGY

under contract DE-AC05-00OR22725

This report was prepared as an account of work sponsored by an agency of the United States government. Neither the United States government nor any agency thereof, nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States government or any agency thereof. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States government or any agency thereof.

Product Specification for a Water Cooled Gate Valve
for the
Material Plasma Exposure Experiment Project

MPEX-04-SPC-504

Author(s):

Ted Boyd
Digitally signed by Ted Boyd
Date: 2023.07.20 14:47:19 -04'00'

Ted Boyd, Mechanical Engineer Date

Reviewer(s):

Digitally signed by Jeffrey Ulreich
Date: 2023.07.20 14:53:32 -04'00'

Jeff Ulreich, Vacuum SME Date

Aftab Hussain
Digitally signed by Aftab Hussain
Date: 2023.07.22 22:24:17 -04'00'

Aftab Hussain, MPEX Lead Engineer Date

DN: cn=Dr. Craig Deibele, email=deibele@ornl.gov, c=US
Date: 2023.07.24 07:52:20 -04'00'

Craig Deibele, MPEX Operations Lead Date

LaTravia N Harmon
Digitally signed by LaTravia N Harmon
Date: 2023.07.24 08:28:53 -04'00'

LaTravia Harmon, Quality Assurance Representative Date

Approver(s):

Robyn Rose
Digitally signed by Robyn Rose
Date: 2023.08.03 14:37:23 -04'00'

Adam M. Aaron, CAM, Vacuum Systems Date

Distribution:
Phil Ferguson, MPEX Project Director
Robyn Rose, MPEX Project Manager

Product Specification for a Water Cooled Gate Valve
for the
Material Plasma Exposure Experiment Project

MPEX- 04-SPC-504

Revision History

Revision	Date	DESCRIPTION OF CHANGE	REVISION TYPE	
			Major	Minor
0	July 2023	Initial Issue	☐	☐
			☐	☐
			☐	☐
			☐	☐
			☐	☐
			☐	☐
			☐	☐

Product Specification for a Water Cooled Gate Valve
for the
Material Plasma Exposure Experiment Project

MPEX- 04-SPC-504

CONTENTS

Product Specification for a Water Cooled Gate Valve
for the
Material Plasma Exposure Experiment Project

MPEX- 04-SPC-504

ACRONYMS

ORNL	Oak Ridge National Laboratory
TLA	Three Letter Acronym
MPEX	Material Plasma Exposure Experiment
TPO	Technical Project Officer
CAD	Computer Aided Design
ECH	Electron Cyclotron Heating
ICH	Ion Cyclotron Heating
PMI	Plasma Material Interaction
NIST	National Institute of Standards and Technology
I&C	Instrumentation and Controls
P&ID	Piping and Instrumentation Design
STEP	Standard for the Exchange of Product Data

1 SCOPE

The specification describes the design requirements for a water cooled gate valve for the MPEX device.

2 INTERCONNECTION FEATURES

The water cooled gate valve must provide interconnection features compatible with DN275CF (Conflat) sealing features. The gate valve shall provide thirty (30) 3/8-24 tapped holes equally spaced on a 12.060" bolt circle on both sides. The bolt holes shall split the gate valve midplane. A four leak check grooves shall be added to each face: 2 along the midplane and two perpendicular to the midplane. The distance between the sealing surfaces shall be nominally 4.088" apart with parallel faces and concentric diameters within typical tolerances for standard gate valves of this size. Sealing features must meet the requirements in *ASTM E2734/E2734M Standard Specification for Dimensions of Knife-Edge Flanges[1]* and *MPEX-00-ENG-002-A2 Vacuum Handbook Appendix 2: Knife Edge Flange Definition[2]*.

3 VACUUM PERFORMANCE

Leak rate in flanges:

- Conflat $<1x10^{-10}$ mbar ls^{-1}

Leak rate when sealed:

- Valve Body $< 1x10^{-8}$ mbar ls^{-1}
- Valve Seat $< 1x10^{-8}$ mbar ls^{-1}

4 MATERIALS

The gate valve body shall be constructed of Grade 316 Stainless Steel and meet the permeability requirements in the *MPEX Vacuum Handbook* [3]. Seals must not outgas beyond the limits of the *MPEX Vacuum Handbook.*

5 EXTERNAL ENVELOPE LIMITATIONS

The external features of the gate valve shall not exceed the envelope shown in Figure 1 below:

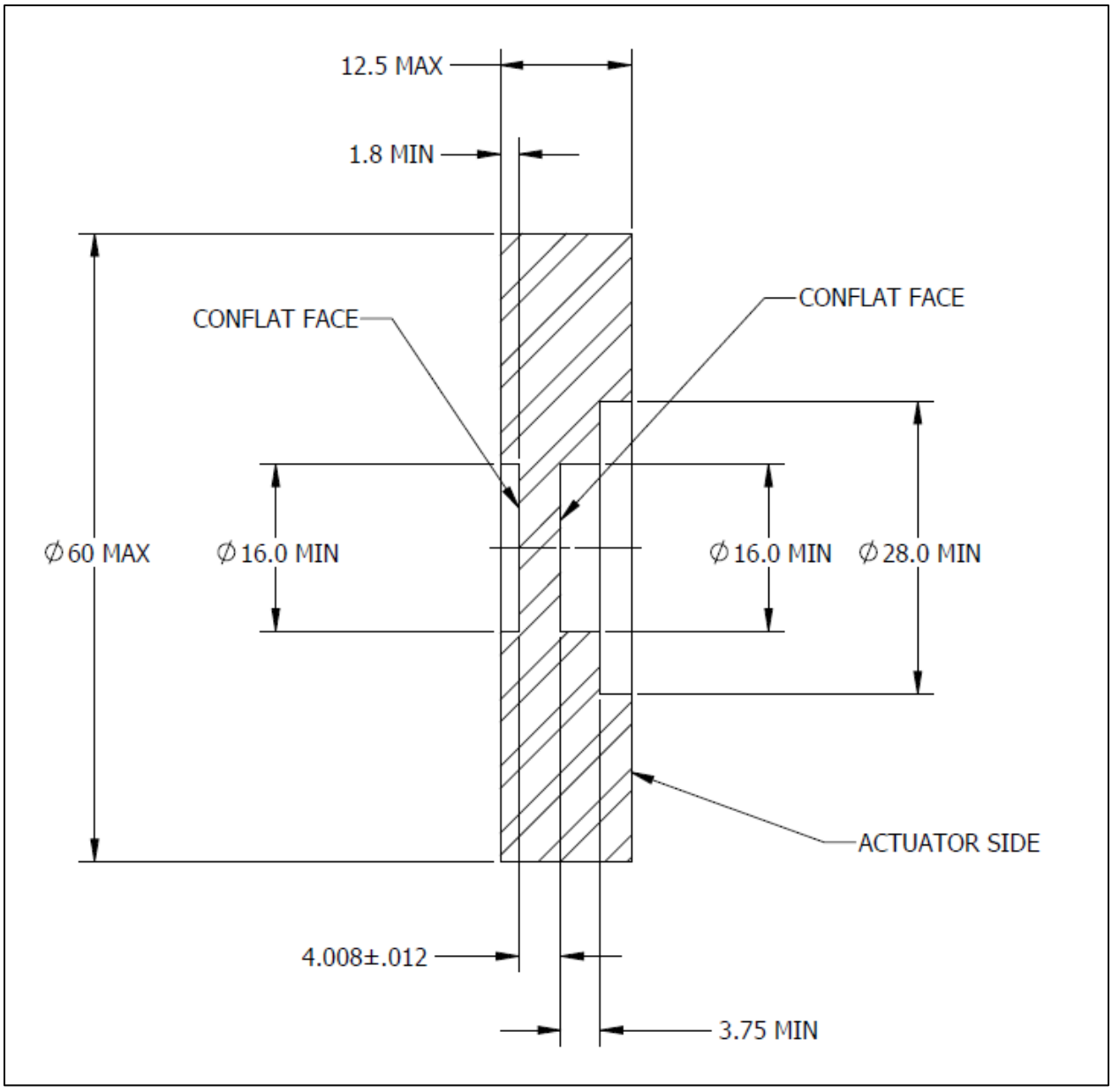

Figure 1: Envelope for Water Cooled Gate Valve

6 THERMAL PERFORMANCE

6.1 HEAT REMOVAL

The gate valve shall provide water cooling capable of removing 2.5 kW from the MPEX device while the gate valve is open to prevent damage to sealing surfaces and operating features of the gate valve. This heat load will only occur when the MPEX plasma is present, and the gate valve is in the open position. The cooling water supplied will be 85°F, 5 GPM, at 220 psig with an allowable pressure drop of up to 17psi.[4]. The 17 psi is nominal. If a greater pressure drop allowance is needed in the design, it must be reviewed and approved by the customer (ORNL).

6.2 WATER CONNECTIONS

The gate valve shall provide ports for cooling water supply and return with standard 0.5 in MNPT Fittings [5]

Connections shall be located on the external face(s) of the Conflat flange, oriented radially on flange perimeter.

All water connections and passageways shall conform to ASTM E1003 for hydrostatic leak checking at 330 psig.

6.3 BAKE OUT

The gate valve shall be able to operate with 150 C water continually flowing through the water channels as part of the MPEX Bakeout Process. All vacuum surfaces shall be allowed to reach 150 C. Critical components may be provided cooling via air or water upon request and review with the buyer.

7 CONTROLS

The gate valve shall be capable of operating while in a 1.0 Tesla magnetic field.

The gate valve shall be controlled remotely by cables and hoses capable of connecting to the MPEX facility I&C system and pneumatics.

30 ft minimum of cable or hose shall be provided for each gate valve

The position of the gate valve, fully open, full closed, must be transmitted to the MPEX facility I&C system. Unless fully opened or closed, neither position should be transmitted.

8 TEST AND INSPECTION

Documentation shall be provided verifying the performance and results of the following tests:

1. Vacuum Leak Check per Section 3.
2. Hydrostatic Leak Check per Section 6.2.

3. Completion of Bake Out per Section 6.3 and operation after cooling to ambient temperature.
4. Cyclic testing - Operation of the gate valve shall be verified and repeated for 100 opening and closing cycles.

9 REFERENCES

[1] *ASTM E2734/E2734M Standard Specification for Dimensions of Knife-Edge Flanges*
[2] *MPEX-00-ENG-002-A2 Vacuum Handbook Appendix 2: Knife Edge Flange Definition*
[3] *MPEX-00-ENG-002 MPEX Vacuum Handbook*
[4] *MPEX-04-ENG-003 MPEX Near-Device Water Client Parameter Summary*
[5] *MPEX-04-PKG-501 Engineering Drawing Package for On-Device water Schematics*