Validation of Safety and Shutdown Valves for Sandy Service

API STANDARD 6AV1

FOURTH EDITION – BALLOT DRAFT

Contents

(TO BE CREATED BY API EDITORS PRIOR TO PUBLICATION)

Introduction

The validation of wellhead surface safety valves (SSVs), boarding shutdown valves (BSDVs), and underwater safety valves (USVs) is an important part of determining their fitness for service. The changes incorporated with this edition of API 6AV1 include but are not limited to the following:

— The 6AV1 was reworded to accommodate USV per specification API 17D.

— Clarify the 6AV1 Sandy Service class III test can be used for other valve sizes or not for safety valve applications, based on the agreement between the manufacturer and purchaser.

Validation of Safety and Shutdown Valves for Sandy Service

1 Scope

There are three service classes, Class I, Class II, and Class III. These service classes are applicable to API 6A surface safety valve (SSV) and boarding shutdown valve (BSDV) and API 17D Underwater safety valve (USV). This standard establishes sandy service design validation for valves to meet Class II and Class III. Class II is intended to validate the valve bore sealing mechanism if substances such as sand can be expected to cause safety or shutdown valve failure. Class III adds additional requirements and validation of the bonnet assembly inclusive of stem seals.

Validation of the actuator is outside the scope of this standard.

NOTE 1 The validation requirements for Class I safety valves are outlined in API 6A.

NOTE 2 This Standard is a test procedure. The selection of an API 6AV1 class for an application is determined by API 6A and API 17D specifications or by the manufacturers and end users.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

API *Manual of Petroleum Measurement Standards* (*MPMS*) Chapter 10.4, *Determination of Sediment and Water in Crude Oil by the Centrifuge Method (Field Procedure)*

API Specification 6A, *Specification for Wellhead and Tree Equipment*

API Specification 17D, *Specification for Subsea Wellhead and Tree Equipment*

API Manual of Petroleum Measurement Standards (MPMS). Chapter 10.4, Determination of Sediment and Water in Crude Oil by the Centrifuge Method

API Recommended Practice 13B-1, *Recommended Practice for Field Testing Water-based Drilling Fluids*

3 Terms, Definitions, and Abbreviations

3.1 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1
actuator
Device that causes the test valve to open when power is supplied and to automatically close when power is lost or released.

3.1.2
failure
Improper performance of a device or equipment item that prevents completion of its design function.

3.1.3
management system
Set of interrelated or interactive elements that establish policy and objectives and provide a means to achieve those objectives.

3.1.4
sandy service
Application where the retained fluid could contain particulates such as sand.

3.1.5
substantive change
Change identified by the manufacturer that affects the performance of the product in the intended service.

3.1.6
test agency
Independent third party that provides a test facility and administers a testing program that meets the test valve validation requirements of this standard.

3.1.7
test valve
Prototype or production valve with an actuator that conforms to the requirements of 4.4.1 or 4.4.2.

3.1.8
validation
Confirmation, through the provision of objective evidence (data), that the requirements for a specific intended use or application have been fulfilled.

NOTE Previous editions referred to this term as “verification test/testing.”

3.1.9
valve
Portion of the SSV/USV/BSDV that contains the well stream retained fluid and shuts off the flow when closed.

3.2 Abbreviations

For the purposes of this document, the following abbreviations apply.

bbl barrels

BSDV boarding shutdown valve

gpm gallons per minute

m^3 cubic meters

m^3/min cubic meters per minute

MPa megapascals

PR performance requirement

PSL product specification level

psi pounds per square inch (gauge)

RWP rated working pressure

SSV surface safety valve

USV underwater safety valve

4 Validation

4.1 General

Validations of API 6A and API 17D valves to Class II that have been completed in accordance with testing requirements of API 14D or previous editions of API 6AV1 or API 6A (Annex I in API 6A 19th and 20th editions) during their validity shall satisfy the requirements of API 6AV1 Class II of this edition.

Validations of valves for Class III that have been completed in accordance with testing requirements of the previous edition of API 6AV1 during its validity shall satisfy the requirements of API 6AV1 Class III of this edition. Validations of valves for Class III shall validate the same valve for Class II in accordance with the scaling limitations in Section 6.

Validations of API 6A or API 17D valves for Class II and III that are members of the same product family, as defined in API 6A, shall be acceptable for either API 6A or API 17D applications.

NOTE 1 The validation requirements in this standard are not represented as duplicating actual well conditions. Complete validation requirements for all classes of safety valves are contained in API 6A, 21st Edition and later and API 17D 3rd edition and later.

NOTE 2 In API 6AV1, First Edition, the terms “PR1 standard service” and “PR2 sandy service” were used to indicate Class I and Class II services, respectively.

4.2 Class II and Class III Valve Validation

To qualify a specific valve design for Class II or Class III, the manufacturer shall submit a test valve to a test agency that meets the requirements of this standard.

Any substantive change in the design or materials of construction that affects the valve bore sealing mechanism shall require requalification by validation testing. Additionally, for Class III, any substantive change to the valve stem seal shall require requalification by validation.

4.3 Test Agency

4.3.1 General

The test agency shall provide a facility, personnel, written procedures, and forms to ensure conformance to the requirements of this standard. The test agency shall maintain a management system and associated documentation that includes as a minimum:

— a description of the facility including any limitations on size or pressure rating of test valve that may be tested;

— test procedures and forms used at the facility;

— basis for determining test scheduling priorities;

— procedures for making application for test, delivery of the test valve, initial installation and checkout of the test valve, and other pertinent information;

— limitations on accessibility of the facility, although such limitations shall not preclude reasonable access to the facility for inspection by manufacturers or equipment owner;

— limitations on receipt of proprietary information;

— any other information considered pertinent by the test agency.

The documentation shall be maintained and furnished to customers upon written request.

Test agencies performing validation testing shall implement and maintain a QMS that conforms to an internationally recognized quality management system such as API Q1 or ISO 9001.

4.3.2 Facility Requirements

4.3.2.1 Design Considerations

The test facility shall be designed to permit the validation as detailed in 5.1 and 5.2 of this standard.

NOTE An example piping arrangement and test section detail of a test facility are shown in Figure 1 and Figure 2, respectively.

4.3.2.2 Circulation System Components

The test facility shall have the following circulation system components as a minimum:

— Freshwater tank: A freshwater tank shall be provided with a minimum capacity of 5 bbl (0.8 m^3).

— Sand slurry tank and associated accessories: A cone-bottom sand slurry tank with a minimum capacity of 5 bbl (0.8 m^3) shall be provided. The tank shall be equipped with agitation as required to obtain proper slurry consistency. Sample connections shall be provided in the tank and in the return line to the tank so that representative sand content and viscosity analysis samples may be taken.

— Circulating pumps and controls: Circulating pumps with drivers and special equipment for pumping the sand slurry and freshwater at the required flow rates and pressures shall be installed. A means of flow control shall be provided.

— Circulation piping and controls: The circulation piping should be installed in an arrangement similar to that shown in Figure 1. Isolation valves should be provided as indicated in Figure 1 and Figure 2. The return piping to the sand slurry tank shall be installed in such a manner as to provide agitation to aid in preventing sand accumulation in the bottom of the tank. A device shall be installed between the circulation pumps and test section and shall be used to control test valve differential pressure to 400 psi (2.8 MPa) during the cycling test (refer to 5.1.3 and 5.2.3).

— Circulation flow meter: The circulation flow meter shall be sized so that the flow rate to be measured falls within the flow meter's calibrated measurement range. This flow meter shall provide an output signal suitable for electronic data acquisition.

— Instrumentation: Pressure measuring devices shall meet the requirements of API 6A. Measurement instrumentation shall be provided to monitor the following data at a minimum:

a) circulation flow rate during all testing,

b) test valve upstream test pressure during the seat test, and

c) differential pressure across test valve during the cycle test.

— Data acquisition system: A data acquisition system shall be provided to gather electronic data from instrumentation on a time-based system.

4.3.2.3 Utility Systems

The manufacturer and test agency shall agree on the fluid media/power source required to operate the test valve and any other associated operating mechanisms.

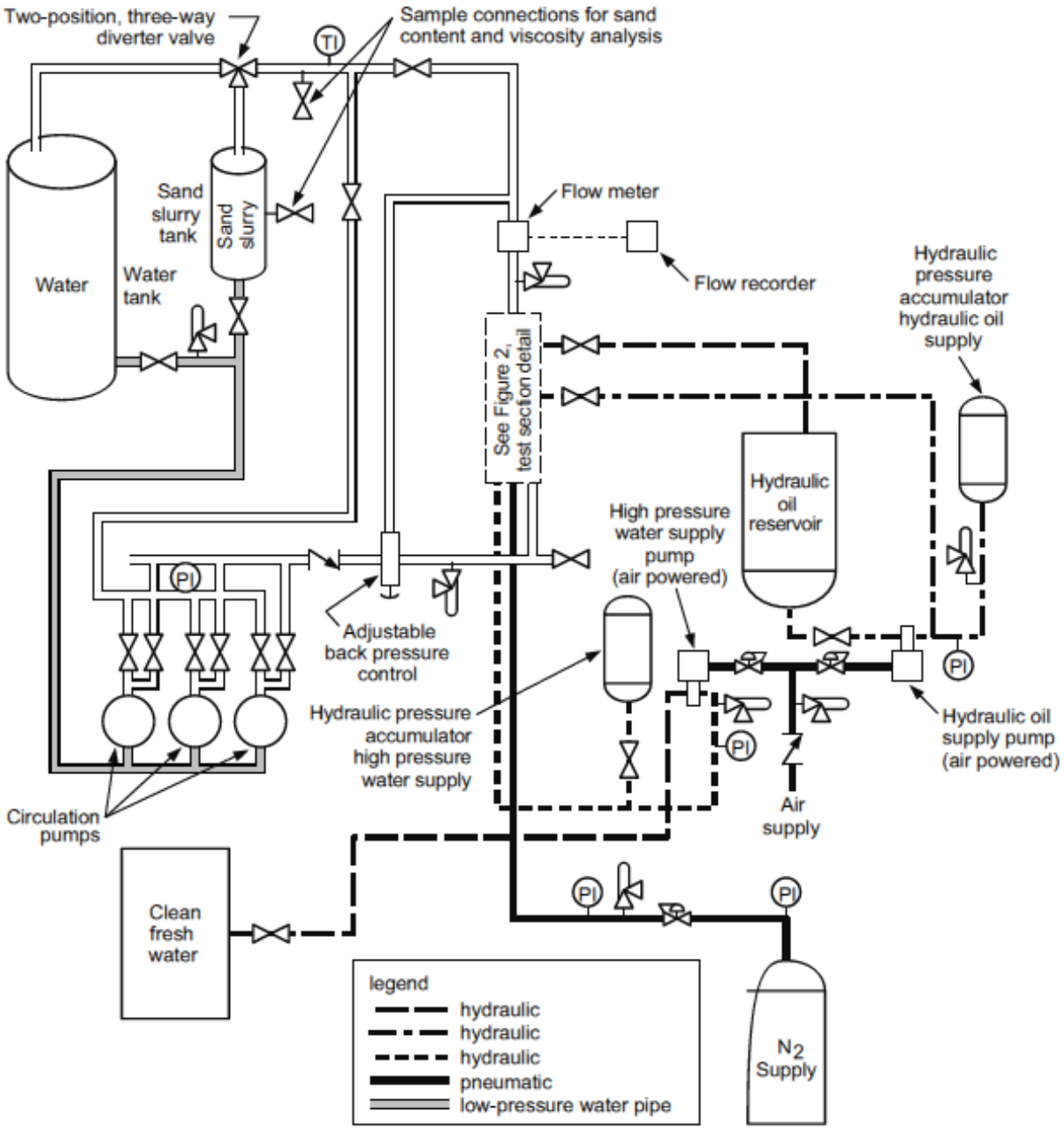

Figure 1—Example Piping Arrangement—Test Facility for Class II Valve Validation

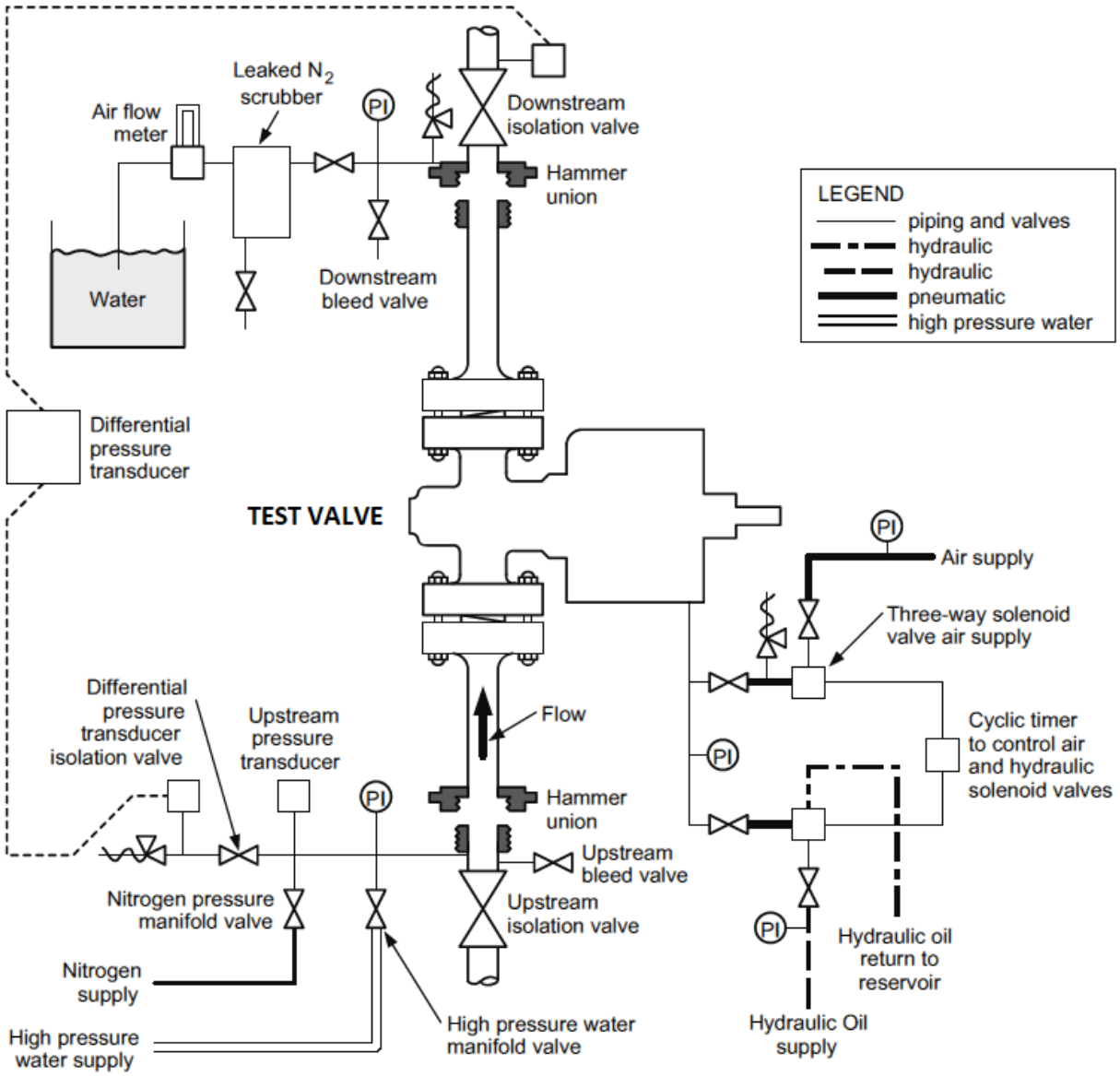

Figure 2—Example Valve Validation Section Detail

4.4 Validation—Requirements

4.4.1 Class II Requirements for Valve

Unless otherwise noted on the valve manufacturer's application, a $2^{1}/_{16}$ in. (52 mm), 5000 psi (34.5 MPa) rated working pressure (RWP) valve shall be used for the validation.

The valve manufacturer shall provide the test agency with one test valve that meets or exceeds the requirements of API 6A, product specification level (PSL) 2 or API 17D product specification level (PSL) 3, in accordance with the data supplied with the manufacturer's test application. The test valve shall be assembled with an actuator of the valve manufacturer's choice. The test valve shall be furnished with an operating manual.

4.4.2 Class III Requirements for Valve

The valve manufacturer shall provide the test agency with one test valve assembly that meets the requirements of API 6A PSL 3G or API 17D PSL 3G as applicable, in accordance with the data supplied with the manufacturer's test application. The test valve shall be assembled with an actuator of the valve manufacturer's choice. The test valve shall be furnished with an operating manual.

If the test valve is other than a $2^{1}/_{16}$ in. (52 mm), 5000 psi (34.5 MPa) RWP valve, manufacturer shall also furnish to the test agency all piping components necessary to install the test valve in the facility test loop, unless the manufacturer has made other arrangements with the test agency.

The test valve shall be equipped with a provision to monitor stem seal leakage during the testing.

4.4.3 Test Application

The valve manufacturer shall declare that a test valve of a specific design and materials of construction is being submitted for the validation by submitting an application to the test agency. The application form shall include the following:

a) manufacturer's name, address, representative, and contact information;

b) designation of retest or initial test and class of test (Class II or Class III);

c) valve data: manufacturer, model or catalog number, part number, serial number, size, RWP, end connector, and any special considerations;

d) actuator data: manufacturer, model or catalog number, part number, serial number, actuation type (pneumatic, hydraulic, other), supply pressure rating, and any special considerations.

NOTE An example of an application form is shown in Table 1.

If a test valve has design or operational features that are incompatible with the test facility and test procedures required by this standard, the manufacturer shall advise the test agency of the nature of the incompatibility and shall request and describe on the test application, or attachment thereto, any nonspecified equipment or procedures required to test the test valve. Responsibility for furnishing and installing nonspecified equipment shall be by agreement between the test agency and the manufacturer. The manufacturer shall document that such nonspecified equipment or procedures are not less stringent than requirements of this standard.

The test agency shall conduct the test as specified on the valve manufacturer's test application. Any variation from the test requirements of this standard shall be recorded in the test report generated by the test agency.

Table 1—Example Application

TEST AGENCY		VALVE ASSEMBLY MANUFACTURER	
Name		Name	
Address		Address	
Qualification Test Class II or Class III		Representative	
Retest (Y/N)		Application Date	
VALVE DATA		**ACTUATOR DATA**	
Manufacturer		Manufacturer	
Model Name		Model Name	
Part Number		Part Number	
Serial Number		Serial Number	
Type (Gate/Ball)		Type (Pneumatic/Hydraulic/Other)	
Nominal Valve Size			
Rated Working Pressure		Maximum Supply Pressure	
End Connections			
Product Specification (API 6A, API 17D) and Special Considerations		Product Specification (API 6A, API 17D) and Special Considerations	

4.4.4 Testing and Test Acceptance Criteria

Class II testing shall conform to 5.1.

Class III testing shall conform to 5.2.

The acceptance criteria shall be as follows.

— Valves shall show no visible leakage during each holding period.

— Monitored pressures shall not vary from the test pressure at the start of the test by more than 5 % or 3.45 MPa (500 psi), whichever is less, during the entire hold period.

— The initial test pressure shall not be greater than 5 % above the specified test pressure.

— During the entire hold period, the monitored pressure shall not drop below the specified pressure.

4.4.5 Test Reporting

The test agency shall record the results of the validation that contain the minimum data specified below:

— identification of product manufacturer (company name, location/address, etc.);

— if retest, reference to previous test number;

— nonstandard equipment required for testing;

— deviations to the test facility procedures;

— equipment type, model, part number, serial number, size, and RWP;

— test results:

a) dates and times at the start and end of all pressure holds and flow rates;

b) test pressures applied and notes on leakage;

c) person(s) performing the tests;

d) sand slurry flow rates;

e) sand slurry sand concentration, temperatures, and viscosities at the start and end of tests;

f) differential test pressures applied during opening/closing cycles;

g) number of opening/closing cycles completed and average cycles per minute;

h) type and frequency of preventive maintenance applied;

i) notes on any testing problems or difficulties;

j) assessment of test results (pass/fail).

NOTE Example forms are shown in Table 2 and Table 3.

The results shall be retained by the manufacturer and the test agency for at least 10 years following the validation. The results shall be available to the equipment owner upon request to the manufacturer and shall be confidential to the party requesting the test and the test agency.

4.4.6 Assessment

The validation test shall include all steps in the order specified by the validation procedure within the limits specified. The validation test cannot continue if the test valve fails to perform within specified limits of any step, except when such failures are determined to be a result of actions by the test agency or malfunction or failure within the test facility. The basis for terminating the validation, and any unusual conditions observed at or prior to the time of termination, shall be noted on the test data form by the test agency; however, the manufacturer shall be responsible for determining the cause of test valve failure.

If a test valve fails to meet the requirements of this section, that valve, or any other valve of the same basic design and materials of construction, shall not be submitted for retest until the valve manufacturer has determined and documented both the need for corrective action and the resolution. Such information shall be placed in the manufacturer's test file before the test valve is submitted for retest.

4.4.7 Records

The manufacturer shall maintain records on each test, including any retest that may have been required to qualify a valve design and surface treatment of valve bore sealing mechanism. The records shall be available to the equipment owner for inspection upon request and shall be retained by the valve manufacturer for a period of at least 10 years after valves of that design are discontinued from production by the manufacturer. As a minimum, the records shall contain documentation to identify and permit retrieval of the following:

— detailed dimensional drawings and material specifications applicable to the test valve at the time that valve was manufactured;

— application(s) for the valve test validation;

— design and material modifications or other justification for retests of valves that did not pass any validation;

— test data specified in this standard;

— model numbers and other pertinent identifying data on all other sizes and RWP of valves of the same basic design and materials of construction that were qualified for Class II or Class III by the validation of the test valve.

Table 2—Example Class II Test Reporting Form

TEST REPORT NUMBER							
I. TEST VALVE AND ACTUATOR INFORMATION							
	Manufacturer	Model	Type	Part No.	Serial No.	Size	RWP
Valve							
Design Specification	API 6A [ ] API 17D [ ]						
Actuator							
II. INITIAL VALVE SEAT SEAL TEST (Table 4)							
Performed by						Date/Time	
1) Liquid Seat Seal Test Pressure (psi)						Leaked (Y/N)	
2) Gas Seat Seal Test Pressure (psi)						Leaked (Y/N)	
III. SAND SLURRY FLOW TEST (Table 5)							
Performed by						Date/Time	
1) Circulation rate of sand slurry (gpm [m^3/min])							
2) Circulating sand slurry (% by volume of 40 to 60 US mesh sand)							
3) Viscosity determined by Marsh funnel viscometer (seconds)							
4) Slurry temperature (°F/°C)							
5) Time of sand slurry circulation (hours)							
6) Liquid Seat Seal Test Pressure (psi)						Leaked (Y/N)	
7) Gas Seat Seal Test Pressure (psi)						Leaked (Y/N)	
IV. SAND SLURRY FLOW TEST WHILE OPENING AND CLOSING VALVE (Table 6)							
Performed by						Date/Time	
1) Circulation rate of sand slurry (gpm [m^3/min])							
2) Circulating sand slurry (% by volume of 40 to 60 US mesh sand)							
3) Viscosity determined by Marsh funnel viscometer (seconds)							
4) Slurry temperature (°F/°C)							
5) Differential pressure across valve when opened (psi)							
6) Average time to complete one cycle (seconds)							
7) Number of test cycles							
8) Liquid Seat Seal Test Pressure (psi)						Leaked (Y/N)	
10) Type and frequency of preventive maintenance. Describe in detail						Leaked (Y/N)	
V. VALVE PERFORMANCE TEST CERTIFICATION (to be completed by a person performing the test or by a test facility–designated certifying officer)							
Remarks—Note any testing problem or difficulties							
Valve qualified for Class II (Y/N)							
Certified by						**Date/Time**	

Table 3—Example Class III Test Reporting Form

TEST REPORT NUMBER							
I. TEST VALVE AND ACTUATOR INFORMATION							
	Manufacturer	Model	Type	Part No.	Serial No.	Size	RWP
Valve							
Design Specification	API 6A [ ] API 17D [ ]						
Actuator							
II. INITIAL VALVE SEAT SEAL TEST (Table 7)							
Performed by						Date/Time	
1) Liquid Seat Seal Test Pressure (psi)						Leaked (Y/N)	
2) Gas Seat Seal Test Pressure (psi)						Leaked (Y/N)	
III. SAND SLURRY FLOW TEST (Table 9)							
Performed by						Date/Time	
1) Circulation rate of sand slurry (gpm [m^3/min])							
2) Circulating sand slurry (% by vol. of 20/40, 40/60, 80/100 US mesh sand)							
3) Viscosity determined by Marsh funnel viscometer (seconds)							
4) Slurry temperature (°F/°C)							
5) Time of sand slurry circulation (hours)							
6) Liquid Seat Seal Test Pressure (psi)						Leaked (Y/N)	
7) Gas Seat Seal Test Pressure (psi)						Leaked (Y/N)	
IV. SAND SLURRY FLOW TEST WHILE OPENING AND CLOSING VALVE (Table 10)							
Performed by						Date/Time	
1) Circulation rate of sand slurry (gpm [m^3/min])							
2) Circulating sand slurry (% by vol. of 20/40, 40/60, 80/100 US mesh sand)							
3) Viscosity determined by Marsh funnel viscometer (seconds)							
4) Slurry temperature (°F/°C)							
5) Differential pressure across valve when opened (psi)							
6) Average time to complete one cycle (seconds)							
7) Number of test cycles							
8) Liquid Seat Seal Test Pressure (psi)						Leaked (Y/N)	
9) Gas Seat Seal Test Pressure (psi)						Leaked (Y/N)	
10) Type and frequency of preventive maintenance. Describe in detail							
11) Number of cycles completed at last preventive maintenance operation							
V. VALVE PERFORMANCE TEST CERTIFICATION (to be completed by a person performing the test or by a test facility–designated certifying officer)							
Remarks—Note any testing problem or difficulties							
Valve qualified for Class III (Y/N)							
Certified by						**Date/Time**	

5 Test Procedures

5.1 Class II Test Procedure

5.1.1 General

Class II testing shall be performed, in the order specified, per requirements outlined in 5.1.2, 5.1.3, and 5.1.4.

NOTE Figure 3 summarizes the applicable testing.

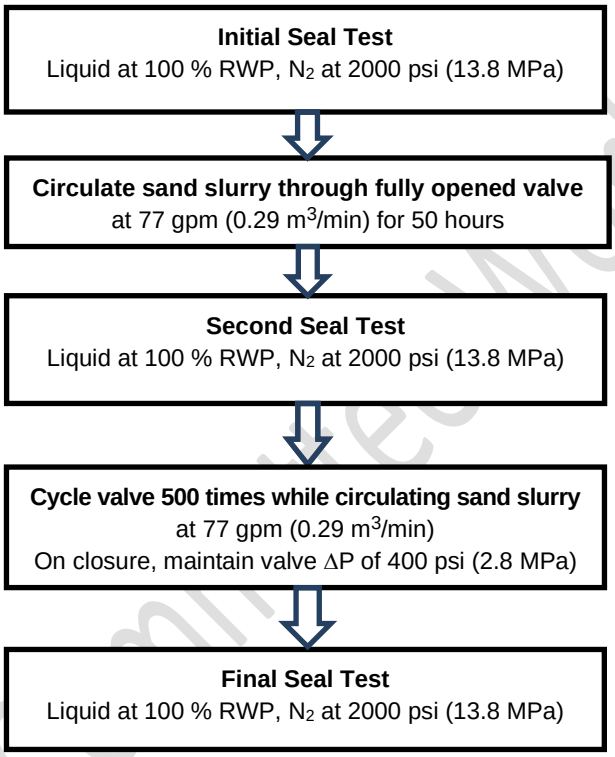

Figure 3—Class II Validation Summary Flow Diagram

5.1.2 Initial Seal Test

The initial seal test shall be performed per Table 4.

Table 4—Class II Initial Seal Test

Step	Procedure Step and Acceptance Criteria	Data to Be Recorded
0)	Verify the identification (model and serial number) of the test valve and actuator before starting the test.	— Valve manufacturer, model, part number, serial number, size, RWP — Actuator manufacturer, model, part number, serial number, type, supply pressure rating
1)	Install test valve in the test flow loop.	
2)	Check test valve for leakage with liquid: a) circulate freshwater at a minimum flow rate of 77 gpm (0.29 m^3/min) but no more than 90 gpm (0.34 m^3/min) for at least 10 minutes with test valve fully open; b) close test valve by releasing actuator power; c) close isolation valves upstream and downstream from test valve; d) open downstream liquid leak detection valve; e) apply water pressure upstream of the test valve equal to 100 % to 105 % of the RWP of the test valve; and f) after the pressure has stabilized within the acceptable range for 3 minutes minimum, check for test valve seat leakage from the downstream leak detection valve for a period of 5 minutes minimum. **Acceptance Criteria:** According to 4.4.4 during the 5-minute hold period.	— Validation number — Date (month/day/year) — Person performing test **Flow Period** — Test start time of flow — Flow rate — Test end time of flow **Pressure Holding** — Test start time of pressure monitoring — Test end time of pressure monitoring — Pressure at start of test — Pressure at end of test — Test passed (yes/no)
3)	Check test valve for leakage with nitrogen pressure: a) close upstream and downstream isolation valves; b) bleed all pressure and drain water on both sides of test valve (open and close test valve three times while draining water); c) close test valve; d) with bleed valve open, immerse the end of a flexible tube connected thereto in a container of water; e) apply 2000 psi (13.8 MPa) ±5 % nitrogen on upstream side of test valve; and f) after the pressure has stabilized within the acceptable range for 3 minutes minimum, check for test valve seat leakage by observing for gas bubbles for a period of 5 minutes minimum. **Acceptance Criteria:** According to 4.4.4 during the 5-minute hold period.	— Test start time of pressure monitoring — Test end time of pressure monitoring — Pressure at start of test — Pressure at end of test — Test passed (yes/no)

5.1.3 Sand Slurry Flow Test

The sand slurry flow test shall be performed per Table 5.

5.1.4 Sand Slurry Flow Test While Opening and Closing during Circulation

The sand slurry flow test while opening and closing during circulation shall be performed per Table 6.

Table 5—Class II Sand Slurry Flow Test

Step	Procedure Step and Acceptance Criteria	Data to Be Recorded
1)	Circulate sand slurry at a minimum flow rate of 77 gpm (0.29 m^3/min) while bypassing the test section until slurry viscosity and sand content stabilize with slurry agitator on.	— Validation number — Date (month/day/year) — Person performing test
2)	Determine sand content of slurry by filling two oil gaugers' 100 ml sample tubes with slurry sample and centrifuge with oil gaugers' centrifuge according to API *MPMS* Ch. 10.4. The use of solvents and temperature controls are not required. Adjust sand content of circulating fluid to 2 % ($1^1/_2$ % to $2^1/_2$ % acceptable) by adding 40 to 60 US mesh sand or diluting mixture with freshwater.	— Sand concentration (%)
3)	Determine viscosity of sand slurry sample with Marsh funnel viscometer according to API 13B-1. Adjust viscosity to 100 sec (120 sec maximum and 90 sec minimum) by adding polymer viscosifier or diluting mixture with freshwater.	— Slurry viscosity (sec)
4)	If dilution or strengthening was necessary in Step 3, return to procedure in Step 1.	
5)	Adjust flow rate to a minimum of 77 gpm (0.29 m^3/min).	— Flow rate at start of circulation period — Slurry viscosity (sec) — Sand concentration (%)
6)	Pump sand slurry through test valve for 25 hours (±1 hour).	— Time at start of slurry circulation through test valve — Time at end of slurry circulation through test valve
7)	Check sand content and viscosity of slurry as before in Step 2 and Step 3; adjust as required.	— Slurry viscosity (sec) — Sand concentration (%)
8)	Pump sand slurry through test valve for an additional 25 hours (±1 hour) at a minimum flow rate of 77 gpm (0.29 m^3/min). The total duration of the flow periods in Step 6 and Step 8 shall be a minimum of 50 hours.	— Time at start of slurry circulation through test valve — Flow rate at start of circulation period — Time at end of slurry circulation through test valve
9)	Check test valve for leakage with liquid: a) close test valve by releasing actuator power; b) close isolation valves upstream and downstream from test valve; c) open downstream liquid leak detection valve; d) apply water pressure upstream of the test valve equal to 100 % to 105 % of the RWP of the test valve; and e) after the pressure has stabilized within the acceptable range for 3 minutes minimum, check for test valve seat leakage from the downstream leak detection valve for a period of 5 minutes minimum. **Acceptance Criteria:** According to 4.4.4 during the 5-minute hold period.	**Pressure Holding** — Test start time of pressure monitoring — Test end time of pressure monitoring — Pressure at start of test — Pressure at end of test — Test passed (yes/no)

10)	Check test valve for leakage with nitrogen pressure: a) close upstream and downstream isolation valves; b) bleed all pressure and drain water on both sides of test valve (open and close test valve three times while draining water); c) close test valve; d) with bleed valve open, immerse the end of a flexible tube connected thereto in a container of water; e) apply 2000 psi (13.8 MPa) ±5 % nitrogen on upstream side of test valve; and f) after the pressure has stabilized within the acceptable range for 3 minutes minimum, check for test valve seat leakage by observing for gas bubbles for a period of 5 minutes minimum. **Acceptance Criteria:** According to 4.4.4. during the 5-minute hold period.	— Test start time of pressure monitoring — Test end time of pressure monitoring — Pressure at start of test — Pressure at end of test — Test passed (yes/no)

Table 6—Class II Sand Slurry Flow Test While Opening and Closing during Circulation

Step	Procedure Step and Acceptance Criteria	Data to Be Recorded
1)	Circulate sand slurry at a minimum flow rate of 77 gpm (0.29 m^3/min) while bypassing the test section until slurry viscosity and sand content stabilize with slurry agitator on.	— Validation number — Date (month/day/year) — Person performing test
2)	Determine sand content of slurry by filling two oil gaugers' 100 ml sample tubes with slurry samples. Centrifuge with oil gaugers' centrifuge according to API *MPMS* Ch. 10.4. The use of solvents and temperature controls are not required. Adjust sand content to 2 % (1.5 % to 2.5 % acceptable) by adding 40 to 60 US mesh sand or diluting mixture with freshwater.	— Sand concentration (%)
3)	Determine viscosity of slurry sample with Marsh funnel viscometer according to API 13B-1. Adjust viscosity to 100 sec (120 sec maximum, 90 sec minimum) by adding polymer viscosifier or diluting mixture with freshwater.	— Slurry viscosity (sec)
4)	If dilution or strengthening was performed in Step 3, return to procedure in Step 1.	
5)	Adjust flow rate to a minimum of 77 gpm (0.29 m^3/min).	— Flow rate at start of circulation period — Slurry viscosity (sec) — Sand concentration (%)
6)	Cycle test valve from fully opened to fully closed at a maximum rate of 7 cycles per minute.	
7)	Adjust choke (or equivalent) upstream from test valve to provide a differential pressure of 400 psi (2.8 MPa) ±10 % across the test valve when closed.	— Differential pressure across test valve when closed (psi)
8)	Open and close test valve a minimum of 500 cycles. During this phase of testing, normal preventive maintenance procedures, if any, as prescribed in the manufacturer's operating manual, shall be performed except that no preventive maintenance shall be allowed during the last 100 cycles of operation in the test and during Step 9 and Step 10.	— Number of cycles — Cycles per minute (nominal) — Type and frequency of maintenance performed (list)
9)	Check test valve for leakage with fresh water: a) close test valve by releasing actuator power; b) close isolation valves upstream and downstream from test valve; c) open downstream liquid leak detection valve; d) apply water pressure upstream of the test valve equal to 100 % to 105 % of the RWP of the test valve; and e) after the pressure has stabilized within the acceptable range for 3 minutes minimum, check for test valve seat leakage from the downstream leak detection valve for a period of 5 minutes minimum. **Acceptance Criteria:** According to 4.4.4 during the 5-minute hold period.	**Pressure Holding** — Test start time of pressure monitoring — Test end time of pressure monitoring — Pressure at start of test — Pressure at end of test — Test passed (yes/no)
10)	Check test valve for leakage with nitrogen pressure: a) close upstream and downstream isolation valves; b) bleed all pressure and drain water on both sides of test valve (open and close test valve three times while draining water); c) close test valve; d) with bleed valve open, immerse the end of a flexible tube connected thereto in a container of water; e) apply 2000 psi (13.8 MPa) ±5 % nitrogen on upstream side of test valve; and f) after the pressure has stabilized within the acceptable range for 3 minutes minimum, check for test valve seat leakage by observing for gas bubbles for a period of 5 minutes minimum. **Acceptance Criteria:** According to 4.4.4 during the 5-minute hold period.	— Test start time of pressure monitoring — Test end time of pressure monitoring — Pressure at start of test — Pressure at end of test — Test passed (yes/no)

5.2 Class III Test Procedure

NOTE Figure 4 summarizes the applicable testing.

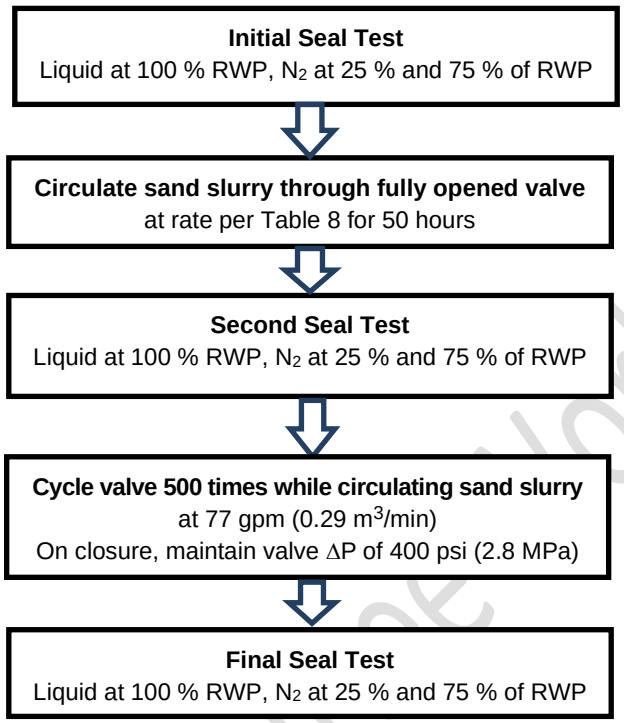

Figure 4—Class III Validation Summary Flow Diagram

5.2.1 Initial Seal Test

The initial seal test shall be performed per Table 7.

Table 7—Class III Initial Seal Test

Step	Procedure Step and Acceptance Criteria	Data to Be Recorded
0)	Verify the identification (model and serial number) of the test valve and actuator before starting the test.	— Valve manufacturer, model, part number, serial number, size, RWP — Actuator manufacturer, model, part number, serial number, type, supply pressure rating
1)	Install test valve in the test flow loop.	
2)	Check test valve for leakage with liquid: a) circulate freshwater at a minimum flow rate of 77 gpm (0.29 m^3/min) but no more than 90 gpm (0.34 m^3/min) for at least 10 minutes with test valve fully open; b) close test valve by releasing actuator power; c) close isolation valves upstream and downstream from test valve; d) open downstream liquid leak detection valve; e) apply water pressure upstream of the test valve equal to 100 % to 105 % of the RWP of the test valve; and f) after the pressure has stabilized within the specified range for 3 minutes minimum, check for test valve seat, stem seal, body, and bonnet seal leakage for a period of 5 minutes minimum. **Acceptance Criteria:** According to 4.4.4 during the 5-minute hold period.	— Validation number — Date (month/day/year) — Person performing test **Flow Period** — Test start time of flow — Flow rate — Test end time of flow **Pressure Holding** — Test start time of pressure monitoring — Test end time of pressure monitoring — Pressure at start of test — Pressure at end of test — Leakage location (if any) — Test passed (yes/no)
3)	Check test valve for leakage with nitrogen pressure: a) close upstream and downstream isolation valves; b) bleed all pressure and drain water on both sides of test valve (open and close test valve three times while draining water); c) close test valve; d) with bleed valve open, immerse the end of a flexible tube connected thereto in a container of water; e) apply 25 % of RWP ±5 % using nitrogen on upstream side of test valve; and f) after the pressure has stabilized within the specified range for 3 minutes minimum, check for test valve seat, stem seal, body, and bonnet seal leakage by observing for gas bubbles for a period of 5 minutes minimum; **Acceptance Criteria:** According to 4.4.4 during the 5-minute hold period. g) apply 75 % of RWP ±5 % using nitrogen on upstream side of test valve; and h) after the pressure has stabilized within the specified range for 3 minutes minimum, check for test valve seat stem seal, body, and bonnet seal leakage by observing for gas bubbles for a period of 5 minutes minimum. **Acceptance Criteria:** According to 4.4.4 during the 5-minute hold period.	**25 % RWP Test** — Test start time of pressure monitoring — Test end time of pressure monitoring — Pressure at start of test — Pressure at end of test — Leakage location (if any) — Test passed (yes/no) **75 % RWP Test** — Test start time of pressure monitoring — Test end time of pressure monitoring — Pressure at start of test — Pressure at end of test — Leakage location (if any) — Test passed (yes/no)

5.2.2 Sand Slurry Flow Test

5.2.2.1 Sand Slurry Composition

The sand slurry composition for the Class III test shall meet the following requirements:

— sand content of 1.5 % to 2.5 % by volume, and

— sand mixture shall be equal quantities by volume of 20/40, 40/60, and 80/100 US mesh sand.

5.2.2.2 Sand Slurry Flow Rate

The Class III sand slurry flow rate shall result in a flow velocity greater than or equal to a flow velocity of 7.4 ft/sec. Table 8 lists the minimum flow rates for common valve sizes.

NOTE 1: The 7.4 ft/sec is based on the flow rate of 77 gpm for a $2^1/_{16}$ valve size,

NOTE 2: Test valves with bore sizes not listed in Table 8 may be tested, provided the 7.4 ft/sec flow velocity requirement is met.

Table 8—Class III Sand Slurry Flow Rates

Nominal Bore Size		Slurry Flow Rate		
in.	(mm)	gpm	bpm	(m^3/min)
$2^1/_{16}$	(52)	77	1.8	(0.29)
$2^9/_{16}$	(65)	119	2.8	(0.45)
$3^1/_{16}$	(78)	170	4.0	(0.64)
$3^1/_8$	(79)	177	4.2	(0.67)
$3^3/_{16}$	(81)	185	4.4	(0.70)
$4^1/_{16}$	(103)	299	7.1	(1.13)
$4^1/_8$	(105)	308	7.3	(1.17)
$4^1/_4$	(108)	328	7.8	(1.24)
$5^1/_8$	(130)	476	11.3	(1.80)
6	(152)	653	15.6	(2.47)
$6^1/_8$	(155)	680	16.2	(2.57)
$6^3/_8$	(162)	739	17.6	(2.80)
$6^5/_8$	(168)	795	18.9	(3.01)
$7^1/_{16}$	(179)	904	21.5	(3.42)
$7^1/_8$	(181)	920	21.9	(3.48)
9	(228)	1470	35.0	(5.56)

5.2.2.3 Test Method

The sand slurry flow test shall be performed per Table 9.

Table 9—Class III Sand Slurry Flow Test

Step	Procedure Step and Acceptance Criteria	Data to Be Recorded
1)	Circulate sand slurry while bypassing the test section until slurry viscosity and sand content stabilize with slurry agitator on.	— Validation number — Date (month/day/year) — Person performing test
2)	Determine sand content of slurry by filling two oil gaugers' 100 ml sample tubes with slurry sample and centrifuge with oil gaugers' centrifuge according to API *MPMS* Ch. 10.4. The use of solvents and temperature controls are not required. Adjust sand content of circulating fluid to 2 % ($1^1/_2$ % to $2^1/_2$ % acceptable) by adding sand mixture or diluting slurry with freshwater.	— Sand concentration (%)
3)	Determine viscosity of sand slurry sample with Marsh funnel viscometer according to API 13B-1. Adjust viscosity to 70 sec (75 sec maximum and 65 sec minimum) by adding polymer viscosifier or diluting slurry with freshwater.	— Slurry viscosity (sec)
4)	If dilution or strengthening was necessary in Step 3, return to procedure in Step 1.	
5)	Adjust flow rate to a minimum per Table 8 corresponding to test valve size.	— Flow rate at start of circulation period — Slurry viscosity (sec) — Sand concentration (%)
6)	Pump sand slurry through test valve for 25 hours (±1 hour).	— Time at start of slurry circulation through test valve — Time at end of slurry circulation through test valve
7)	Check sand content and viscosity of slurry as before in Step 2 and Step 3; adjust as required.	— Slurry viscosity (sec) — Sand concentration (%)
8)	Pump sand slurry through test valve for an additional 25 hours (±1 hour) at a minimum flow rate per Table 8 corresponding to test valve size. The total duration of the flow periods in Step 6 and Step 8 shall be a minimum of 50 hours.	— Time at start of slurry circulation through test valve — Flow rate at start of circulation period — Time at end of slurry circulation through test valve
9)	Check test valve for leakage with fresh water: a) close test valve by releasing actuator power; b) close isolation valves upstream and downstream from test valve; c) open downstream liquid leak detection valve; d) apply water pressure upstream of the test valve equal to 100 % to 105 % of the RWP of the test valve; and e) after the pressure has stabilized within the acceptable range for 3 minutes minimum, check for test valve seat, stem seal, body, and bonnet seal leakage for a period of 5 minutes minimum. **Acceptance Criteria:** According to 4.4.4 during the 5-minute hold period.	— Validation number — Date (month/day/year) **Pressure Holding** — Test start time of pressure monitoring — Test end time of pressure monitoring — Pressure at start of test — Pressure at end of test — Leakage location (if any) — Test passed (yes/no)

Table 9—Class III Sand Slurry Flow Test *(continued)*

Step	Procedure Step and Acceptance Criteria	Data to Be Recorded
10)	Check test valve for leakage with nitrogen pressure: a) close upstream and downstream isolation valves; b) bleed all pressure and drain water on both sides of test valve (open and close test valve three times while draining water); c) close test valve; d) with bleed valve open, immerse the end of a flexible tube connected thereto in a container of water; e) apply 25 % of RWP ±5 % using nitrogen on upstream side of test valve; and f) after the pressure has stabilized within the acceptable range for 3 minutes minimum, check for test valve seat, stem seal, body, and bonnet seal leakage by observing for gas bubbles for a period of 5 minutes minimum; **Acceptance Criteria:** According to 4.4.4 during the 5-minute hold period. g) apply 75 % of RWP ±5 % using nitrogen on upstream side of test valve; and h) after the pressure has stabilized for 3 minutes minimum, check for test valve seat, stem seal, body, and bonnet seal leakage by observing for gas bubbles for a period of 5 minutes minimum. **Acceptance Criteria:** According to 4.4.4 during the 5-minute hold period.	**25 % RWP Test** — Test start time of pressure monitoring — Test end time of pressure monitoring — Pressure at start of test — Pressure at end of test — Leakage location (if any) — Test passed (yes/no) **75 % RWP Test** — Test start time of pressure monitoring — Test end time of pressure monitoring — Pressure at start of test — Pressure at end of test — Leakage location (if any) — Test passed (yes/no)

5.2.3 Sand Slurry Flow Test While Opening and Closing during Circulation

The sand slurry flow test while opening and closing during circulation shall be performed per Table 10.

Table 10—Class III Sand Slurry Flow Test While Opening and Closing during Circulation

Step	Procedure Step and Acceptance Criteria	Data to Be Recorded
1)	Circulate sand slurry while bypassing the test section until slurry viscosity and sand content stabilize with slurry agitator on.	— Validation number — Date (month/day/year) — Person performing test
2)	Determine sand content of slurry by filling two oil gaugers' 100 ml sample tubes with slurry samples. Centrifuge with oil gaugers' centrifuge according to API *MPMS* Ch. 10.4. The use of solvents and temperature controls are not required. Adjust sand content to 2 % (1.5 % to 2.5 % acceptable) by adding sand mixture or diluting slurry with freshwater.	— Sand concentration (%)
3)	Determine viscosity of slurry sample with Marsh funnel viscometer according to API 13B-1. Adjust viscosity to 70 sec (75 sec maximum, 65 sec minimum) by adding polymer viscosifier or diluting mixture with freshwater.	— Slurry viscosity (sec)
4)	If dilution or strengthening was necessary in Step 3, return to procedure in Step 1.	
5)	Adjust flow rate to a minimum of 77 gpm (0.29 m^3/min).	— Flow rate at start of circulation period — Slurry viscosity (sec) — Sand concentration (%)
6)	Cycle test valve from fully opened to fully closed at a maximum rate of 7 cycles per minute.	

7)	Adjust choke (or equivalent) upstream from test valve to provide a differential pressure of 400 psi (2.8 MPa) ±10 % across the test valve when closed.	— Differential pressure across test valve when closed (psi)

Table 10—Class III Sand Slurry Flow Test While Opening and Closing during Circulation *(continued)*

Step	Procedure Step and Acceptance Criteria	Data to Be Recorded
8)	Open and close test valve a minimum of 500 cycles. During this phase of testing, normal preventive maintenance procedures, if any, as prescribed in the manufacturer's operating manual, shall be performed except that no preventive maintenance shall be allowed during the last 100 cycles of operation in the test and during Step 9 and Step 10.	— Number of cycles — Cycles per minute (nominal) — Type and frequency of maintenance performed (list)
9)	Check test valve for leakage with fresh water: a) close test valve by releasing actuator power; b) close isolation valves upstream and downstream from test valve; c) open downstream liquid leak detection valve; d) apply water pressure upstream of the test valve equal to 100 % to 105 % of the RWP of the test valve; and e) after the pressure has stabilized within the acceptable range for 3 minutes minimum, check for test valve seat, stem seal, body, and bonnet seal leakage for a period of 5 minutes minimum. **Acceptance Criteria**: According to 4.4.4 during the 5-minute hold period.	**Pressure Holding** — Test start time of pressure monitoring — Test end time of pressure monitoring — Pressure at start of test — Pressure at end of test — Leakage location (if any) — Test passed (yes/no)
10)	Check test valve for leakage with nitrogen pressure: a) close upstream and downstream isolation valves; b) bleed all pressure and drain water on both sides of test valve (open and close test valve three times while draining water); c) close test valve; d) with bleed valve open, immerse the end of a flexible tube connected thereto in a container of water; e) apply 25 % of RWP ±5 % using nitrogen on upstream side of test valve; and f) after the pressure has stabilized within the acceptable range for 3 minutes minimum, check for test valve seat, stem seal, body, and bonnet seal leakage by observing for gas bubbles for a period of 5 minutes minimum; **Acceptance Criteria:** According to 4.4.4 during the 5-minute hold period. g) apply 75 % of RWP ±5 % using nitrogen on upstream side of test valve; and h) after the pressure has stabilized for 3 minutes minimum, check for test valve seat, stem seal, body, and bonnet seal leakage by observing for gas bubbles for a period of 5 minutes minimum. **Acceptance Criteria:** According to 4.4.4 during the 5-minute hold period.	**25 % RWP Test** — Test start time of pressure monitoring — Test end time of pressure monitoring — Pressure at start of test — Pressure at end of test — Leakage location (if any) — Test passed (yes/no) **75 % RWP Test** — Test start time of pressure monitoring — Test end time of pressure monitoring — Pressure at start of test — Pressure at end of test — Leakage location (if any) — Test passed (yes/no)

6 Scaling of Test Results

6.1 General

NOTE Scaling is independent of the PSL of the test valve.

6.2 Scaling of Class II Validation Results

Successful completion of the validation on an API 6A or API 17D $2^{1}/_{16}$ in. (52 mm), 5000 psi (34.5 MPa) RWP test valve shall validate all sizes and all pressure ratings of that manufacturer's valves of the same basic design and

materials of construction for Class II service.

Successful completion of the validation on a size or pressure rating other than API 6A or API 17D $2^{1}/_{16}$ in. (52 mm), 5000 psi (34.5 MPa) RWP test valve shall validate that size and larger for all pressure ratings of that manufacturer's valves of the same basic design and materials of construction for Class II service.

Any substantive change in the design or surface treatments that affects the valve bore sealing mechanism shall require revalidation.

6.3 Scaling of Class III Validation Results

6.3.1 Requirements and Limitations

Scaling of Class III validation results shall be permitted within a product family when the criteria in 6.3 are satisfied.

6.3.2 Product Family

A product family shall meet the following design requirements.

a) The design principles of physical configuration and functional operation are the same.

b) The allowable design stress levels in relation to material mechanical properties are based on the same criteria.

6.3.3 Scaling by Pressure Rating

The validation results of a test valve shall validate products of the same product family having equal or lower pressure ratings.

6.3.4 Scaling by Size

The validation results of one size of a product family shall validate products one nominal size larger and one nominal size smaller than the tested size.

The validation results of two sizes of a product family shall validate all nominal sizes between the two sizes tested and the sizes one nominal size larger and one nominal size smaller than the tested size (if applicable). The valve nominal size shall be defined as the nominal size of the end connectors, as defined in API 6A or API 17D or by the bore size of the valve bore sealing mechanisms, if not defined in API 6A or API 17D.

For valves of the same product family:

a) the $1^{13}/_{16}$ and $2^{1}/_{16}$ sizes shall be considered as one size for scaling purposes;

b) the $3^{1}/_{16}$, $3^{1}/_{8}$, and $3^{3}/_{16}$ sizes shall be considered as one size for scaling purposes;

c) the $4^{1}/_{16}$, $4^{1}/_{8}$, and $4^{1}/_{4}$ sizes shall be considered as one size for scaling purposes;

d) the 6, $6^{1}/_{8}$, $6^{3}/_{8}$, $6^{5}/_{8}$, $7^{1}/_{16}$, and $7^{1}/_{8}$ sizes shall be considered as one size for scaling purposes.

For valves where the flow bore diameters do not follow API 6A or API 17D nominal sizes in table 8; the scaling based on flow bore diameters shall be used. The validation results of two tested valves of a product family shall validate all flow bore diameters between.

Bibliography

[1] API *Manual of Petroleum Measurement Standards* (*MPMS*) Chapter 15, *Guidelines for the Use of the International System of Units (SI) in the Petroleum and Allied Industries*

[2] API Specification 14D, *Wellhead Surface Safety Valves for Offshore Service*