API 14A 12th Edition Overview Addressing Critical Service and HPHT SSSV Applications

Darren Bane – Baker Hughes

March 17, 2015

API 14A 12th Edition – Addressing Critical Service and HPHT SSSV Applications

- API 14A Twelfth Edition Overview
- New Validation Levels and Associated Testing Requirements
- Additional Testing Requirements (when specified)
- HPHT Annex Requirements for Design Verification and Validation
- HPHT Additonal Requirements

API 14A 12th Edition Overview

- Published Jan 2015, Effective Jan 2016
  - Extensive changes justified 12 month implementation timeframe
- Key Revision highlights –
  - Entire document reviewed and modified
  - Added 6 new Validation Grades in lieu of Classes of Service
  - Scope now includes Injection Valves (SSISV) with validation testing

API 14A 12th Edition Overview

- Key Revision highlights –
  - Added Normative and Informative Test Annexes to align with new Validation Levels
  - Insert SCSSV's harmonized with API RP14B.
  - Design analysis methods added, including FEA and CFD
  - Design Verification and Validation added for:
    - HPHT Environments and Applications (new Annex)
    - Alternate technology SSSV's
    - Secondary Tools for SSSV's (new Annex)

API 14A 12th Ed - New Validation Levels and Associated Testing Requirements

- New Validation Levels replace previous Classes of Service designations
  - Allows better alignment with SSSV requirements based on end user determination of testing required
- Accommodates legacy equipment for previous Class 1 and Class 2 validation ratings
- New V1 and V1-H defined for critical or HPHT applications
  - New V2 and V3 builds upon previous Class 1 & 2 with additional testing requirements
- Removed Class 3 & 4, now in mat'l req's section

API 14A 12th Ed - New Validation Levels and Associated Testing Requirements

Validation Grade	Comments	Historical Class of Service (API 14A)
V4-1	Validation grade V4-1 shall only be used for SSSVs that have a validation test date prior to the effective date of this specification. The validation requirements are specified in Annex B and are equivalent to API 14A, 9th, 10th, and 11th editions, Class 1 requirements.	1—standard service
V4-2	Validation grade V4-2 shall only be used for SSSVs that have a validation test date prior to the effective date of this specification. The validation requirements are specified in Annex B and are equivalent to API 14A, 9th, 10th, and 11th editions, Class 2 requirements.	2—sandy service
V3	Validation grade V3 (see 5.5.1 and 5.5.3) contains the validation test requirements specified in Annex B and additional supplier/manufacturer tests in Annex D. It also contains requirements for special feature validation (see 5.5.9) and electronics qualification (see G.7), if applicable.	None—new to this edition
V2	Validation grade V2 (see 5.5.1 and 5.5.4) contains the validation test requirements specified in Annex B and additional supplier/manufacturer tests in Annex D. It also contains requirements for special feature validation (see 5.5.9) and electronics qualification (see G.7), if applicable.	None—new to this edition
V1	Validation grade V1 (see 5.5.5) SSSVs meet all the requirements of Annex B in this edition of API 14A plus additional testing detailed in Annex G.	None—new to this edition
V1-H [a]	Validation grade V1-H (see Annex H) SSSVs meet all the requirements of Annex B in this edition of API 14A plus additional testing detailed in Annex G, Annex J, and Annex L.	None—new to this edition
N/A	This edition of API 14A does not provide requirements for Class 3 or Class 4 SSSVs. Material requirements for all SSSVs are defined in Sections 4 and 5.	3—stress cracking service 4—mass loss corrosion service

[a] When validation testing is completed, a fully validated HPHT SSSV has been tested to Annex C functional test, Annex B V2 testing, Annex G operating life testing, differential opening test, equalizing mechanism endurance test, special feature validation, alternate technology qualification (if applicable), Annex J combined load operational testing at temperature, and Annex L dynamic piston seal system test.

Validation Grade	Grades Covered
V1-H	V1-H, V1, V2, V3, V4-2, V4-1
V1	V1, V2, V3, V4-2, V4-1
V2	V2, V3, V4-2, V4-1
V3	V3, V4-1
V4-2	V4-2, V4-1
V4-1	V4-1

API 14A 12th Ed - New Validation Levels and Associated Testing Requirements

V3 Validation Test

B.2 Table B.1 - Test Agency V3 steps

- B.3 Gas flow test
- B.5 Liquid leakage test
- B.6 Unequalized opening test
- B.7 Operating-pressure test
- B.8 Propane test
- B.9 Nitrogen leakage test
- B.7 Operating-pressure test
- B.10 V3 water flow test
- Repeat B.9, B.7, and B.10 four times
- B.5 Liquid leakage test
- B.11 Controlled-temperature test
- B.4 OD/ID Drift per B.4.2/B.4.3

New Requirements:

- D.2 Temperature Cycle Test
- D.3 Differential Opening Testing
- D.4 Self-Equalizing Test (if applicable)
- Body Joint Evaluation

V2 Validation Test

B.2 Table B.2 - Test Agency V2 steps

- Table B.1 (Steps 1-15)
- B.7 Operating-pressure test
- B.12 V2 Slurry Flow Test
- B.9 Nitrogen Leakage Test
- Repeat B.12 and B.9 six times
- B.5 Liquid leakage test
- B.4 OD/ID Drift per B.4.2/B.4.3

New Requirements:

- D.2 Temperature cycle test
- D.3 Differential opening testing
- D.4 Self-Equalizing Test (if applicable)
- Body Joint Evaluation

V2 validation completed

API 14A 12th Ed - New Validation Levels and Associated Testing Requirements

V1 Validation Test

From a V2 validated valve, add:

G.3 Operating Life Test (500 cycles min.)

G.4 Differential Opening Testing

G.5 Equalization Mechanism Endurance Testing

G.6 Special feature validation

G.7 ESSSV Electronics qualification (if applicable)

Annex M Rated Performance Envelope

V1-H Validation Test

From a V1 validated valve, add:

- Annex J Combined Load Operational Test
- Annex L Dynamic Seal System Test

API 14A 12th Ed – Additional Testing

- Additional testing has been defined for user/purchasers to specify when required

Annex Identification	Annex Title	General Description of Content	Purpose
E	Alternative requirements for closure mechanism minimal leakage	Provides alternative leakage acceptance criteria for the functional test	Provides more stringent leak rate acceptance criteria
I	Extended sand endurance testing	Enhanced sand endurance testing	Evaluates the ability of the valve design to close and seal in sandy conditions
J	Combined loads operational test	Validation of closed end rated performance envelope limits	Confirms the ability of the SSSV to operate at the limits of the performance envelope
K	Gas slam closure testing	Testing requirements for high-rate slam closures	Evaluates closure of SSSV in increased flow rate gas wells
L	Dynamic seal system test	Testing requirements for primary dynamic seal systems at intermediate positions at static conditions	Evaluates gas sealing integrity of the dynamic seal system

API 14A 12th Ed – HPHT Annex Requirements for Design Verification and Validation

- New Annex H defines HPHT SSSV requirements
  - Defines the additional verification and validation requirements that shall be followed in designing and manufacturing SSSV and secondary tools for use in HPHT environment
- H.2 – Functional specification (User/purchaser requirements)
  - Additional requirements are to be specified including max flowing temperature, shut in static temperature, and duration of time that SSSV will operate at temperature
- H.3 – Technical specification (Supplier/manufacturer requirements)
  - **Temperature effects** – use temperature de-rated yield strength and modulus of elasticity with testing on samples at mid-wall or mid radius conducted in accordance with ASTM E21 and E111
  - **Environmental effects** – compatibility of metals with well fluids shall be evaluated, limits on castings (API 20A), limits on welding/structural components

API 14A 12th Ed – HPHT Annex Requirements for Design Verification and Validation

- H.3 – Technical specification (Supplier/manufacturer requirements)
  - **Non-metals** – completions and stimulation fluid exposure to be specified, compound evaluation for RGD and ageing along with compound validation testing and evaluation
  - **Design Verification** – User/purchaser specifies max anticipated shut-in tubing pressure (SITP) at the SSSV and specify RWP > SITP.
  - The component shall conform to the requirements of 6.4 and the following additional requirements:
    - For all metallic components integral to the tubing string and closure mechanism, perform an elastic-plastic FEA using ASME BPVC Section VIII, Division 2
    - Localized stress discontinuities and localized yielding shall be evaluated by a qualified person to determine if the design is acceptable or if additional analysis is required
    - When FEA has identified plastic strain in excess of 0.2 %, a ratcheting analysis shall be performed per ASME BPVC Section VIII, Division 3, Paragraph KD-234 or ASME BPVC Section VIII, Division 2, Paragraph 5.5.7
    - Perform a fatigue screening per ASME BPVC Section VIII, Division 2, Paragraph 5.5.2. If the design exhibits fatigue sensitivity, conduct a fatigue analysis per API 579/ASME FFS-1 using a safety factor of 2 on anticipated operating life

API 14A 12th Ed – HPHT Annex Requirements for Design Verification and Validation

- H.3 – Technical specification (Supplier/manufacturer requirements)
  - **Design Validation** – V1-H is normative, post-test NDE is required on all critically stressed components from combined load test
  - **Scaling of HPHT SSSV's** – comprehensive material review for scaled designs (metal & non-metal) shall be reviewed and accepted

H.4 – Additional supplier/manufacturer requirements

- **Metals verification** – yield strengths and modulus of elasticity for components integral to the tubing string and the closure mechanism shall be documented at max rated operating temperature
- **Functional Test Requirements** – the functional test pressure used in Annex C shall be a minimum of 1.25 times RWP
- **Quality Plan** – shall be prepared per ISO 10005 and 6.4 for each order placed and approved in writing by user/purchaser, any changes shall go through the same approval process
- **Final Design Review** – final design review to verify that the SSSV and secondary tools are suitable for the applicable HPHT environment

Questions?