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PROCEDURE

EXTRUDED HOT TAP & LINE STOP TEES – DESIGN & MANUFACTURING VALIDATION

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| Date: 28/03/2018 | Date: 28/03/2018 |

DOCUMENT DEVELOPMENT HISTORY

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| UNI-FORGE | Title: Extruded Hot Tap & Line Stop Tees – Design & Manufacturing Validation | |
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Build Status:

| Version | Date | Author | Reason | Sections |
|---------|------------|--------|-----------------|----------|
| A | 28.03.2018 | | Initial Release | All |
| | | | | |


Amendments in this Release:

| Section Title | Section Number | Amendment Summary |
|---------------|----------------|-------------------|
| | | |

Distribution:

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1. SCOPE

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This procedure outline methods adopted for design validation of full encirclement tees to specific requirements, it is evaluated through both virtual & physical testing.

Virtual validation - Finite Element Analysis (FEA).

Physical validation testing - Hydro Test, Strength Test, Proof Test & Burst Test.

2. REFERENCES

This document has been prepared in accordance with the requirements of the following international codes & standards:

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|-------------------------|---|
| ASME B31.1 | Power Piping |
| ASME B31.3 | Process Piping |
| ASME B31.4 | Pipeline Transportation Systems for Liquids and Slurries |
| ASME B31.8 | Gas Transmission and Distribution Piping Systems |
| ASME SECTION II | Materials |
| ASME SECTION VIII Div.1 | Rules for construction of Pressure Vessels |
| ASME SECTION IX | Welding, Brazing and Fusing Qualifications |
| ASME B16.9 | Factory-Made Wrought Butt welding Fittings |
| ASME B16.5 | Pipe Flanges and Flanged Fittings (NPS ½" through 24") |
| ASME B16.47 | Large Diameter Steel Flanges (NPS 26" through 60") |
| MSS SP-75 | Specification for High-Test, Wrought, Butt-Welding Fittings |
| DOT 49 CFR Part 192 | Transportation of natural and other gas by pipeline: minimum federal safety standards |


3. VIRTUAL VALIDATION OF FITTING DESIGN

3.1 FINITE ELEMENT ANALYSIS (FEA)

FEA investigation considers only the flange, plug, and collet(s) components to “make-up” the Flange Assembly

The FEA design verification consists of the following:

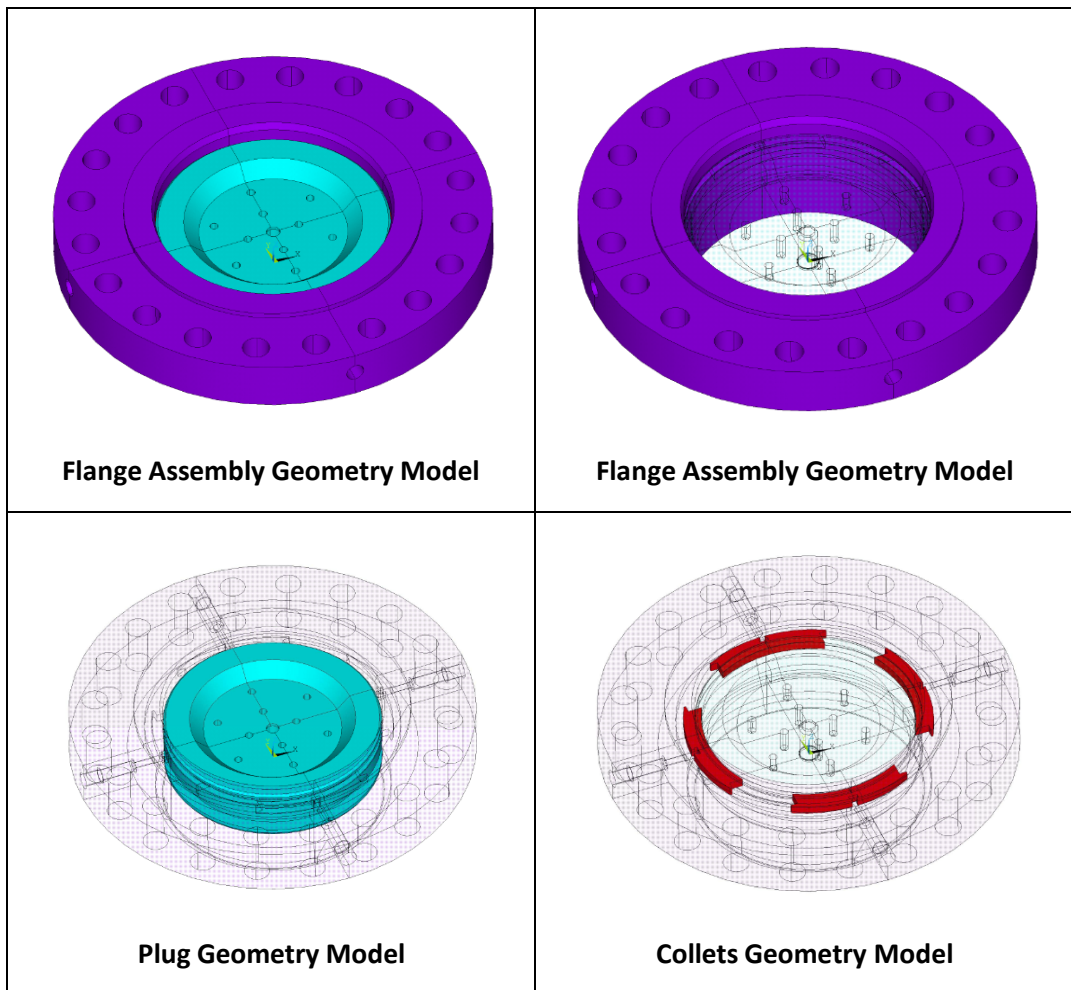
- Using linear FEA, determine the structural stresses that develop in the Flange Assembly when subjected to a design pressure.
- Using material non-linear FEA, estimate the maximum pressure that will cause the Flange Assembly to fail plastically (i.e., FE model fails to converge numerically).


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3.1.1 Software for FEA

- ANSYS should be used for the geometric modeling and FEA of the Flange Assembly components.
- SOLID185 elements should be used for analyzing of the flange assembly.
- Contact elements (i.e., TARGET170 and CONTACT174) should be used to model / simulate contact between the individual components (i.e., plug to Collets and collets to flange) that makeup the Flange Assembly.

3.1.2 Geometric Models



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4. PHYSICAL VALIDATION OF FITTING DESIGN

Physical validation testing involves Hydro Test, Strength Test, Proof Test & Burst Test.

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| Hydro Test | In accordance with ASME Section VIII Div.1 & ASME B31.1 / B31.3 / B31.4 / B31.8, for a design factor of 0.72. Test pressure at 1.5 x MAOP (Maximum Allowable Operating Pressure) with a hold time of 4 hours. |
| Strength Test | In accordance with CFR 192, §192.153. Test pressure at 2 x MAOP (Maximum Allowable Operating Pressure) with a hold time of 4 hours. |
| Proof Test | In accordance with ASME B16.9. Test pressure at 2.5 x MAOP (Maximum Allowable Operating Pressure) with a hold time of minimum 3 minutes. |
| Burst Test | Utilizes the testing methodology in ASME B16.9. Pressurize system until lack of pressure containment occurred (maximum pressure). |

4.1 Pre-Job Checks


- 4.1.1 All the components of test equipment shall be adequate to provide necessary test pressure at a safe rate of increases.
- 4.1.2 Dial indicating pressure gauges used in testing shall be graduated over a range of about double the intended maximum test pressure, but in no-case shall the range be less than 1.5 nor more than 4 times that pressure.
- 4.1.3 Ensure that pressure gauges & chart recorders had valid calibration stickers. Gauges & chart recorders shall be recalibrated at any time that there is reason to believe that they are in error.

4.2 Preparation for test

- 4.2.1 Blind flanges and gaskets shall be installed as necessary. All fittings shall be tightened except the vent points.
- 4.2.2 All lines and appurtenances which do not form part of the test system shall be removed or isolated from the test system before the test.
- 4.2.3 Vents shall be provided at all high points of the test system in the position in which it is to be tested to purge possible air pockets while filling.
- 4.2.4 Water shall be used as test medium.

4.3 Test fluid filling

- 4.3.1 All vents shall be opened.
- 4.3.2 The test fluid shall be filled from the lowest point in the system, progressing towards the vents on completion to minimize the risk of entrapped air. The rate of flow should be such that it does not cause excessive bubbles which may be entrapped in recesses.
- 4.3.3 The vents shall be closed after filling the test system completely and ensuring that no air is left entrapped within the test system.

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4.4 Test procedure

4.4.1 Test Arrangement – Tee with completion plug (without blind flange)

- 4.4.1.1 Test arrangement should be as per appendix 1.
- 4.4.1.2 Pressurize the test system gradually to the required hydrotest pressure. (ie, 1.5 x MAOP). The holding period for hydro test shall be 4 hours.
- 4.4.1.3 Any leaks observed during pressurizing shall be rectified before pressurizing the system to full test pressure.
- 4.4.1.4 Allow the pressure to stabilize. Re-pressurize to the full test pressure if required.
- 4.4.1.5 Once the test pressure is stabilized, QA/QC Engineer shall record the start time of the test. At this holding time, QA/QC Engineer shall visually check for any leakages or pressure drops.
- 4.4.1.6 The pressure test is deemed fail, if system is unable to maintain the required test pressure or any leaks detected at the weld joints or parent material. Suitable repairs methods shall be adopted in accordance with approved repair procedures.
- 4.4.1.7 For any leak observed outside the test system (such as at a pump connection or outlet valve) the leak shall be immediately rectified, and the test shall be repeated.
- 4.4.1.8 On successful completion of the test, QA/QC Engineer shall record the data in Design Validation Test Certificate (Appendix 3).
- 4.4.1.9 After completing the test, the pressure shall be gradually decreased & completion plug shall be removed.

4.4.2 Test Arrangement – Tee with blind flange (without completion plug)

- 4.4.2.1 Test arrangement should be as per appendix 2.
- 4.4.2.2 Pressurize the test system gradually to the required hydrotest pressure. (ie, 1.5 x MAOP). The holding period for hydro test shall be 4 hours.
- 4.4.2.3 Any leaks observed during pressurizing shall be rectified before pressurizing the system to full test pressure.
- 4.4.2.4 Allow the pressure to stabilize. Re-pressurize to the full test pressure if required.
- 4.4.2.5 Once the test pressure is stabilized, QA/QC Engineer shall record the start time of the test. At this holding time, QA/QC Engineer shall visually check for any leakages or pressure drops.
- 4.4.2.6 The pressure test is deemed fail, if system is unable to maintain the required test pressure or any leaks detected at the weld joints or parent material. Suitable repairs methods shall be adopted in accordance with approved repair procedures.
- 4.4.2.7 For any leak observed outside the test system (such as at a pump connection or outlet valve) the leak shall be immediately rectified, and the test shall be repeated.
- 4.4.2.8 On successful completion of the test, QA/QC Engineer shall record the data in Design Validation Test Certificate (Appendix 3).
- 4.4.2.9 All flange segment ports shall be plugged.
- 4.4.2.10 For Strength test, the pressure shall be gradually increased to Strength test pressure (i.e., 2 x MAOP). The holding period for strength test shall be 4 hours.
- 4.4.2.11 Repeat steps 4.4.2.3 to 4.4.2.8.

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- 4.4.2.12 For Proof test, the pressure shall be gradually increased to proof test pressure (i.e., 2.5 x MAOP). The holding period for proof test shall be minimum 3 minutes.
- 4.4.2.13 Repeat steps 4.4.2.3 to 4.4.2.8.
- 4.4.2.14 For burst test, the pressure shall be increased to a point where the system fails catastrophically. Failure pressure & failure location shall be recorded in Design Validation Test Certificate (Appendix 3).

5. APPENDICES

Appendix 1: Physical Validation Test Arrangement – Tee with completion plug (without blind flange)

Appendix 2: Physical Validation Test Arrangement – Tee with blind flange (without completion plug)

Appendix 3: Design Validation Test Certificate

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