

GENERAL SPECIFICATION

PIPING VALVES VESSELS

GS EP PVV 441

Procedure for shop hydraulic tests of shell and tube heat exchangers

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General Specification		GS EP PVV 441
Procedure for shop hydraulic tests of shell and tube heat exchangers		
Rev.: 04	Effective date: 10/2016	Page: 2 of 21

Contents

1. Scope	4
2. Reference documents.....	4
3. Preliminary arrangements for testing.....	5
3.1 Pneumatic test of reinforcements.....	5
3.2 Preparation of openings	5
4. Pressure gauges	5
5. Test devices.....	5
5.1 Test flange	6
5.2 Test gland	6
5.3 Test ring, gland and packing gland.....	6
6. Running of test.....	6
6.1 Pressurization	6
6.2 Duration of testing	7
6.3 Helium leak test	7
6.4 Test sequences.....	7
7. Arrangement to be made following testing.....	8
Standard for floating-head exchangers (SD EP PVV 441).....	10
Standard for floating-head exchangers (SD EP PVV 442).....	11
Standard for floating-head exchangers (SD EP PVV 443).....	12
Standard for floating-head exchangers (SD EP PVV 444).....	13
Standard for floating-head exchangers (SD EP PVV 445).....	14
Standard for floating-head exchangers (SD EP PVV 446).....	15
Standard for U-tube exchangers (SD EP PVV 451).....	16
Standard for U-tube exchangers (SD EP PVV 452)	17
Standard for U-tube exchangers (SD EP PVV 454).....	18

General Specification		GS EP PVV 441
Procedure for shop hydraulic tests of shell and tube heat exchangers		
Rev.: 04	Effective date: 10/2016	Page: 3 of 21

Standard for U-tube exchangers (SD EP PVV 455)	19
Standard for exchangers with fixed tube-sheets (SD EP PVV 461).....	20
Standard for exchangers with fixed tube-sheets (SD EP PVV 462).....	21

General Specification		GS EP PVV 441
Procedure for shop hydraulic tests of shell and tube heat exchangers		
Rev.: 04	Effective date: 10/2016	Page: 4 of 21

1. Scope

This specification defines the minimum requirements for the leak tests and the shop hydrostatic tests of shell and tube heat exchangers. It applies to all exchangers designed and built in accordance with the provisions of general specification **GS EP PVV 411**.

The purposes of the tests described in this specification are the following:

- Hydrostatic test of the shell and tube heat exchanger in accordance with the selected pressure design code
- Detection and location of any leaks or deformation there might be:
 - On shell side or on tube side
 - On a defective tube
 - At tube-to-tubesheet joint
 - At contact faces
 - Under reinforcements (i.e. nozzle or saddle reinforcement).

2. Reference documents

The reference documents listed below form an integral part of this General Specification.

Any conflicting requirements between this specification and any other relevant document shall be reported to the Company for decision. In any case, and notwithstanding the final decision of the Company, the most stringent requirement is always first meant to govern.

External Documents

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published at the effective date of this document.

Reference	Title
ASME BPVC Section V	Non-Destructive Examination
TEMA	Standards of the Tubular Exchanger Manufacturers Association

Total General Specifications

Unless otherwise stipulated, the applicable version of these documents, including relevant appendices and addendums, is the latest revision published.

Reference	Title
GS EP PVV 411	Shell and tube heat exchangers

General Specification		GS EP PVV 441
Procedure for shop hydraulic tests of shell and tube heat exchangers		
Rev.: 04	Effective date: 10/2016	Page: 5 of 21

3. Preliminary arrangements for testing

3.1 Pneumatic test of reinforcements

Prior to the hydrostatic test and before the heat exchanger is filled with test water, the reinforcements shall undergo pneumatic testing. This shall be done by the introduction of compressed air at 1.7 bar gauge between the pressure part (shell, head) and the reinforcements at the telltale hole of the reinforcing pad.

The visible weld seams shall be coated with soapy water to detect any leaks that might exist.

3.2 Preparation of openings

3.2.1 Blanking of openings

All openings shall be blanked except the following:

- Vents
- The opening for the test pressure gauge
- The telltale holes of the reinforcing pads, in order to check the absence of moisture between the shell and the reinforcement (if moisture is present, any appropriate means shall be used to dry this zone, so as to eliminate any ambiguity at the time of test).

3.2.2 Orientation and arrangement of the openings used during the test

The openings shall be placed along the top generating line. This reminder applies to the case of vertical exchangers, which are always shop tested in a horizontal position.

A single opening may be used to advantage for these two functions, with the pressure gauge connected to the vent pipe; this pipe shall be fitted with a plug cock that is tight at the test pressure (see Figure 1, attached to this specification).

4. Pressure gauges

Two pressure gauges must be installed on the circuit:

- A reference pressure gauge, which shall be placed on the highest point of the exchanger.
- Another pressure gauge shall be placed close to the pump discharge readily visible to the operator controlling the pressure.

The pressure gages shall be graduated over a range of about two times the maximum intended test pressure. In no case the range shall be less than one and one-half times nor more than four times the intended test pressure.

All gages shall be calibrated at least every six months.

5. Test devices

The test devices are defined in the [TEMA](#) depending on the type of shell & tube heat exchanger.

They consist basically of:

- A test flange or a test gland
- A test ring, gland and packing gland.

5.1 Test flange

The test flange shall consist of a ring of the same diametrical dimensions than the partition-head or shell flange having the larger inside diameter. The drilling shall be identical to those of these two flanges. The thickness of the test flange shall be equal to that of the partition-head or shell flange of the exchanger, whichever is thicker.

Typical test flange is shown on figure E-4.13-1 of the [TEMA](#).

5.2 Test gland

The test gland shall consist of a flange/stuffing-box/packing assembly having outside and drilling diameters identical to those of the shell cover flange. The inside diameter shall be equal to the outside diameter of the floating tube-sheet increased of the air gap necessary for a safe and efficient installation of the packing. The packing must be such as to assure complete tightness along the perimeter of the tube-sheet at the test pressure. The type of packing and packing arrangement is subject to Company approval.

Typical test gland is shown on figure E-4.13-1 of the [TEMA](#).

5.3 Test ring, gland and packing gland

Test ring, gland and packing gland, in accordance with [TEMA](#), Figure E-4.13-2 or equivalent shall be used for heat exchanger with floating head.

In addition, for [TEMA](#) type T floating head, a complete set of blind collar nuts must be provided so as to assure the tightness of the end-sheet attachment bolting hole. Tightness may be assured either by a ring-shaped flat gasket with holes matching the bolting holes, or by individual gaskets inserted under each blind nut.

6. Running of test

Test pressure P_T shall be established in accordance with the selected pressure design Code.

6.1 Pressurization

Pressurization must be gradual. For test pressures higher than 40 bars, pressurization shall be in stages, with a pause of a few minutes between stages.

The use of three stages minimum is recommended:

- 0 to $1/3 P$
- $1/3$ to $2/3 P$
- $2/3$ to P

For test pressures higher than 120 bars, the first plateau shall be at 40 bars and the second at $\frac{P + 40}{2}$.

6.2 Duration of testing

The hold time of the hydrostatic test must never be less than 60 minutes for shells up to 25 mm thick; this minimum duration shall be increased to $\frac{60 \text{ minutes} \times \text{thickness in mm}}{25}$ in the case of thicknesses greater than 25 mm (but shall not exceed two hours).

6.3 Helium leak test

When tube-to-tubesheet joint is strength welded, a helium leak test shall be performed before the hydrostatic test.

The test shall follow the requirements of the [ASME BPVC Section V](#) Article 10 Mandatory Appendix IX "Helium mass spectrometer test - Hood technique" unless another technique and acceptance criteria are required by the project specification.

The pressure with helium shall be applied on the shell side. The test pressure shall be 7 barg or 10% of the design pressure (shell side) whichever is the less.

6.4 Test sequences

The pressure and leak tests shall be carried-out according various test sequences depending on the heat exchanger [TEMA](#) type.

In particular, the examinations prescribed for each sequence shall be made using the final bolting and gasket for each element that need not be moved thereafter for a subsequent sequence. In addition, it shall be checked by visual examination that there is no trace of moisture between the pressure part and the reinforcing pads.

The test sequence shall follow the Test Sequence Standard listed in the Table 1 below.

Table 1 - List of the test sequence standards with reference to [TEMA](#) Type

	TEMA Type	Applicable Test Sequence Standard
Floating-head heat exchanger	AES, AFS, AGS, AHS, AJX, AXS	SD EP PVV 441
	BES, BFS, BGS, BHS, BJX, BXS	SD EP PVV 442
	AET, AFT, AGT, AHT, AJT, AXT	SD EP PVV 443
	CET, CFT, CGT, CHT, CJT, CXT & CKT	SD EP PVV 444
	AKT	SD EP PVV 445
	BKT	SD EP PVV 446