

THE FOLLOWING PARAGRAPH NUMBERS REFER TO API STANDARD 660, 5TH EDITION, JUNE 1993,
TITLED, "SHELL-AND-TUBE HEAT EXCHANGERS FOR GENERAL REFINERY SERVICES,"
WHICH IS A PART OF THIS PRACTICE

SECTION 1 - GENERAL

- 1.1 SCOPE
 - 1.1.1 API-660, 5th Edition, June 1993, as amended by this IP, defines the minimum requirements for shell-and-tube heat exchangers for general refinery services.
 - I 1.1.3 (New) Only the paragraphs amended are listed. For user convenience, nature of amendment is noted at the beginning of each paragraph as follows:
 - 1. (Addition) - This note means that the paragraph specifies additions to the corresponding API paragraph.
 - 2. (Exception) - This note means that the paragraph completely replaces the corresponding API paragraph.
 - 3. (New) - This note means that the paragraph does not appear in API Standard 660 and denotes new requirements.
 - I 1.1.4 (New) **An asterisk (*)** indicates that a decision by the Purchaser is required or that additional information shall be furnished by the Purchaser. This additional information is transmitted in Appendix B of this practice. All paragraphs with a bullet (•) in the API are addressed in this practice.
- 1.2 GENERAL
 - I ↕ * 1.2.1 (Addition) Unless otherwise specified by the Purchaser, the heat exchangers shall be designed and manufactured per TEMA Class "R" requirements. Codes of other countries are permitted per [IP 5-1-1](#).
- 1.3 REFERENCED PUBLICATIONS
 - I ↕ 1.3.1 (New) **Table 1** lists the practices and standard which shall be used with this practice.

TABLE 1

PRACTICES	
IP 3-16-1	Flanged Joints, Gaskets, and Bolting
IP 5-1-1	Pressure Vessels
IP 20-1-1	Inspection of Equipment and Materials
STANDARD	
API Standard	
660	Shell and Tube Heat Exchangers for General Refinery Services

- I * 1.3.2 (New) **Table 2** lists the practices and standard that shall be used with this practice if specified by the Purchaser.

TABLE 2

PRACTICES	
IP 3-8-1	Expansion Joints
IP 5-1-2	Additional Requirements for Heavy Wall Pressure Vessels, Thickness Over 2 Inches
IP 18-4-1	Post Weld Heat Treatment of Equipment Handling Alkaline Solutions
IP 19-1-1	Paint and Protective Coatings
IP 19-2-1	Weld Overlay and Integrally Bonded Cladding
IP 19-4-1	Glass Reinforced Plastic Linings
IP 19-4-2	Natural and Synthetic Rubber Linings
STANDARD	
ASTM Standard	
A 320 / A 320M	Alloy Steel Bolting Materials for Low-Temperature Service

IP 6-1-1		TEMA Type Shell-and-Tube Heat Exchangers	
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(This practice is appropriate for attachment to Inquiry or Purchase Document)

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I 1.4 DEFINITION OF TERMS

- c. (Addition) Effective surface. The area associated with tube bends in U-tube bundles shall be considered as effective heat transfer surface in kettle-type reboilers only.

SECTION 2 - PROPOSALS

2.2 VENDOR'S RESPONSIBILITIES

- I * 2.2.7 (Exception) Spare gaskets shall not be supplied unless otherwise specified by the Owner's Engineer.
- I * 2.2.8 (New) If specified by the Owner's Engineer, the proposal shall include a copy of a detailed description of the Vendor's quality assurance program. This is required to contain a positive materials identification program for alloy components.

SECTION 4 - DESIGN

4.1 DESIGN TEMPERATURE

- R ♦ * 4.1.1 (Exception) All exchangers shall have two design temperatures for each side, a maximum design temperature as specified on API-660, Appendix D, Line 34, and a critical exposure temperature (CET), specified by Owner's Engineer in Appendix B.
- R 4.1.3 (New) For fixed tubesheet exchangers without expansion joints, the differential between the average shell metal temperature and the average metal temperature of any one tube pass shall not exceed 50°F (28°C). When temperature differentials exceed 50°F (28°C), an expansion joint shall be furnished.
- R 4.1.4 (New) For two-pass-shell exchangers the differential between the inlet and the outlet temperatures of the shell side fluid shall not exceed 350°F (194°C).

4.2 CLADDING FOR CORROSION ALLOWANCE

- R 4.2.1 (New) The type and effective depth of cladding shall be **as specified by the Purchaser**. The effective depth of cladding shall be applicable to all exposed surfaces, after machining, INCLUDING THE SIDES AND BOTTOMS OF PASS PARTITION GROOVES, other gasket contact surfaces and facings of nozzles.

4.3 SHELL SUPPORTS

- R 4.3.2. a. (Addition) Saddle bearing plates shall be 1/4 inch (6 mm) minimum thickness.

4.5 FLOATING HEAD

- M 4.5.6 (New) A recommended split ring design for TEMA type "S" units is shown in [Figure 1](#) of this practice.

4.6.1 TUBES

- R 4.6.1.5 (New) When finned tubes are specified, the tube wall thickness under the root diameter of the fins shall meet the thickness specified on the Heat Exchanger Specification Sheet.
- R 4.6.1.6 (New) Integrally finned U-tubes shall be finned in the bend area, except when the mean bend diameter is less than 6 outside tube diameters, in which case the entire bend plus 2 inches beyond the tangent shall be unfinned.

4.7 NOZZLES AND OTHER CONNECTIONS

- M 4.7.7 (Addition) The projection of a flanged connection shall provide adequate clearance (including insulation) when a valve is to be installed on the neck of the nozzle
- R 4.7.11 (New) Threaded connections shall not be provided on exchanger components that are of clad construction where the design temperature is greater than or equal to 750°F (400°C) or the component is subject to PWHT.

4.8 FLANGED EXTERNAL GIRTH JOINTS

- R * 4.8.3 (Addition) Nubbins shall not be provided unless approved by the Owner's Engineer.

4.9 GASKETS

- R 4.9.1 (Exception) With the exception of corrugated metal graphite covered (CMGC) and grooved metal graphite covered (GMGC), solid flat metal gaskets shall not be used in the girth flange joints. Gasket type and material for girth flange joints shall be in accordance with [IP 3-16-1](#) and shall be selected per [Table 3](#) for fluid services compatible with the intended gasket materials.

TABLE 3

Service Fluid	Equivalent ASME Rating	Design Temperature Range °F (°C)	Gasket Type
Hydrocarbons	150	750 (400) and below	Double-jacketed, Spiral Wound, CMGC, or GMGC
		Above 750 (400) to 975 (525)	Double-jacketed, Spiral Wound or GMGC
		Above 975 (525) to 1000 (540)	Spiral Wound
	300	-50 (-45) to 750 (400)	Double-jacketed, Spiral Wound, CMGC, or GMGC
		Above 750 (400) to 975 (525)	Spiral Wound or GMGC
		Above 975 (525) to 1000 (540)	Spiral Wound
	400 & 600	-50 (-45) to 975 (525)	Double-jacketed, Spiral Wound, or GMGC
		Above 975 (525) to 1000 (540)	Spiral Wound
	900 and higher	-50 (-45) to 975 (525)	Spiral Wound or GMGC
		Above 975 (525) to 1000 (540)	Spiral Wound
Hydrogen or Helium	150	750 (400) and below	Double-jacketed, Spiral Wound, CMGC, or GMGC
		Above 750 (400) to 900 (480)	Double-jacketed, Spiral Wound or GMGC
		Above 900 (480) to 1000 (540)	Spiral Wound
	300	-50 (-45) to 750 (400)	Double-jacketed, Spiral Wound, CMGC, or GMGC
		Above 750 (400) to 900 (480)	Spiral Wound or GMGC
		Above 900 (480) to 1000 (540)	Spiral Wound
	400 & 600	-50 (-45) to 900 (480)	Double-jacketed, Spiral Wound, or GMGC
		Above 900 (480) to 1000 (540)	Spiral Wound
	900 and higher	-50 (-45) to 900 (480)	Spiral Wound or GMGC
		Above 900 (480) to 1000 (540)	Spiral Wound
Steam	150 and 300	750 (400) and below	Double-jacketed, Spiral Wound, CMGC, or GMGC
		Above 750 (400) to 975 (525)	Spiral Wound or GMGC
		Above 975 (525) to 1000 (540)	Spiral Wound
	400, 600 and 900	975 (525) and below	Double-jacketed, Spiral Wound, or GMGC
		Above 975 (525) to 1000 (540)	Spiral Wound
Air or other oxidizing media	150 and 300	750 (400) and below	Double-jacketed, Spiral Wound, or GMGC
		Above 750 (400) to 975 (525)	Spiral Wound or GMGC
		Above 975 (525) to 1000 (540)	Spiral Wound
Water (including boiler feed)	150, 300, 400, 600 and 900	Any	Double-jacketed, Spiral Wound, or GMGC
	1500	Any	Spiral Wound or GMGC
Toxic Materials, including acids and caustics	300 and lower	750 (400) and below	Double-jacketed, Spiral Wound, CMGC, or GMGC
Refrigerant and Refrigerated Hydrocarbon	300 and lower	400 (200) and below	Double-jacketed, Spiral Wound, CMGC, or GMGC
		below -50 (-45)	Spiral Wound, GMGC
	above 300	-50 (-45) to 400 (200)	Double-jacketed, Spiral Wound, or GMGC