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KLM Technology Group #03-12 Block Aronia, Jalan Sri Perkasa 2 Taman Tampoi Utama 81200 Johor Bahru Malaysia	INTERNALS FOR FIXED BED REACTORS (PROJECT STANDARDS AND SPECIFICATIONS)	

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SCOPE

This Project Standard and Specification covers requirements governing the design, fabrication, and inspection of beams, grids, trays, shrouds, thermowells, and other internals for fixed bed reactors.

REFERENCES

Throughout this Standard the following dated and undated standards/codes are referred to. These referenced documents shall, to the extent specified herein, form a part of this standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor. For undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

1. American society of Mechanical Engineers (ASME)

Section VIII	Pressure Vessels, Alternative Rules, Division 2
Section IX	Welding and Brazing Qualifications
B31.3	Chemical Plant and Petroleum Refinery Piping
Section VIII	Pressure Vessels, Division

2. American Society for Testing and Materials (ASTM)

A36	Structural Steel
A167	Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip
A176	Stainless and Heat-Resisting Chromium Steel Plate, Sheet, and Strip
A193/A193M	Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service
A194/A194M	Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service
A204/A204M	Pressure Vessel Plates, Alloy Steel, Molybdenum
A240	Heat-Resisting Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels
A276	Stainless Heat-Resisting Steel Bars, and Shapes
A283/A283M	Low and Intermediate Tensile Strength Carbon Steel Plates
A285/A285M	Pressure Vessel Plates, Carbon Steel, Low-and Intermediate-Tensile Strength
A307	Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength

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A387/A387M	Pressure Vessel Plates, Alloy Steel, Chromium-Molybdenum
A414/A414M	Steel, Sheet, Carbon for Pressure Vessels
A569/A569M	Steel, Carbon (0.15 Maximum, Percent) Hot-Rolled Sheet and Strip Commercial Quality
A570/A570M	Steel, Sheet and Strip, Carbon, Hot-Rolled, Structural Quality
A675/A675M	Steel Bars, Carbon, Hot-Wrought, Special Quality, Mechanical Properties
B127	Nickel-Copper Alloy (UNS NO4400) Plate, Sheet and Strip
B164	Nickel-Copper Alloy Rod, Bar, and Wire
B265	Titanium and Titanium Alloy Strip, Sheet and Plate
B348	Titanium and Titanium Alloy Bars and Billets

DEFINITIONS AND TERMINOLOGY

Major beams - beams 10 ft. (3000 mm) and longer, or beams regardless of length that extend across a vessel without interruption. All other beams shall be considered as minor beams.

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MATERIALS

- Acceptable grades and specifications for a number of standard internal materials are listed below:

MATERIALS	ASTM STANDARDS				
	PLATE	SHEET	STRIP	BARS	BOLTS & NUTS
Carbon Steel	A 283, A 285, A 36	A 414, A 569	A 570	A 675	A 307, GrB
Low and Intermediate Alloy Steels C-1/2Mo	A 204	As specified for High Alloy Steels			
1-1/4Cr-1/2Mo through 5 Cr-1/2Mo	A 387				
High Alloy Steels 12Cr: welded components	A 176 and A 240, Types 405 and 410S		A 276 Type 405	A 193 B6, and A 194 Gr6F (with Selenium), or Gr8	
12Cr: non-welded components	A 176 and A 240, Types 405, 410 and 410S		A 276 Type 405 or 410		
18Cr 8Ni: Types 304, 316, 321, 347	A 167 and A 240		A 276	A 193 B8 and A 194 Gr8	
Non-Ferrous Nickel Copper (Monel)	B 127		B 164	B 164	
Titanium	B 265 Gr2		B 348 Gr2	B 348 Gr4	

- Vendor's proposals to use materials, or thicknesses alternative to those specified shall be submitted to purchaser for approval by Owner's Engineer.
- When materials are not specified. Vendor's proposals shall be submitted to purchaser for approval by Owner's Engineer.
- Free machining grades of steel are not permitted, except that Type 416 nuts furnished to ASTM A194 Gr6F with Selenium are acceptable for use with ASTM A193 B6 bolts.

Gasketing

Fiber reinforced PTFE shall be used for acid or caustic service below 600°F (315°C).

Bolting

All bolting for internals shall be a minimum of 3/8 in. (10 mm) diameter. All bolting hardware shall be of the same type of material as the internals which they are connecting or which being connected to support members. However, 12 Cr shall be used for unlined carbon steel vessels (with carbon steel internals) when the specified corrosion allowance for the shell is greater than 1/8 in. (3 mm).

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Thermowells

Materials for thermowells will be specified.

The wall thickness of thermowells shall include a corrosion allowance equal to one-half that specified for structural components.

Screen For Scale Traps, Outlet Collector and Bed Support Grids

Material for wire screen and tie wire (where required) will be specified. Wire screen dimensions shall be per Table 2.

DESIGN

Vessel internals which contribute to the total reactor height shall be designed for minimum height. Similar parts shall be interchangeable where possible.

All internals, except shrouds, shall be removable with vertical thermowells in place, and shall be designed to pass through the nearest manhole above their level.

All removable internals shall be designed to permit installation and removal from the top side.

Screens shall be attached on top of grids and catalysts support hardware to prevent inerts and catalyst from:

- Fallings through holes or slot openings
- Blocking clearances in support hardware that are required for thermal expansion.

Loads and Stresses

1. Reactor internals shall be designed to support their own weight plus specified design live loads. For trays and decks, this design shall be based on a corroded thickness of 0.06 in. (1.5 mm).
2. Maximum deviation from the horizontal for liquid distributor trays under loaded conditions shall not exceed 1/900 of the reactor diameter.
3. Maintenance loads. Support members shall be designed for a concentrated live load of 300 lb (135 kg) at any point based on the allowable stress at 100°F (38°C). This design shall be based on the corroded thickness of the support members: i.e., total thickness excluding corrosion allowance.

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4. Allowable unit stresses for metal shall be per ASME Code Section VIII, Div. 2. For stresses beyond the temperature range listed in the ASME Code, ASME B31.3 shall be used.

Minimum Metal Thickness and Corrosion Allowance

1. For internals fabricated from sheet, plate, or strip, and for internal piping, the minimum acceptable total metal thickness (including corrosion allowance) is given in Table 1 for the specified CORROSION DESIGN CATEGORY and VESSEL SHELL CORROSION ALLOWANCE (or METAL LINING or CLADDING THICKNESS).

Unless otherwise specified, CORROSION DESIGN CATEGORY "10 yr." shall be used.

2. Supporting members formed as integral part of the tray deck shall have the same total thickness as the tray.
3. The total corrosion allowance (TCA) to be added to the design thickness of support members (major beams, support rings, etc.) is given in Table 1 for the specified CORROSION DESIGN CATEGORY and VESSEL SHELL CORROSION ALLOWANCE (or METAL LINING OR CLADDING THICKNESS).

Liquid Distributor Trays, Quench Decks, Splash Decks, and Bed Support Grids

1. The nominal diameter of trays, decks and grids shall be determined to the nearest 1/4 in. (5 mm) per the following:
Diameter = Vessel ID — [1% Vessel ID + 3/4 in. (19 mm)]
2. A minimum of 3/4 in. (19 mm) overlap under the most adverse operating conditions shall be provided between the support ring and the OD of trays, decks, and grids.
3. Bolt hole spacing around the edge of tray, deck, and grid sections shall not exceed 7 in. (177 mm).
4. Access through grids, decks, and trays shall be provided either by split construction or by use of manways, as follows:
 - Manways shall provide a minimum rectangular opening of 15 x 18 in. (380 x 460 mm), except as provided below
 - Access through liquid distributor trays shall be at least 2 ft. (600 mm) wide, and of sufficient length to permit catalyst leveling and arrangement of the inert ball layer at the top of each bed by a man lying on the tray. Assume a maximum reach of 3 ft. (900 mm) from the edge of the any opening.