

KLM Technology Group Project Engineering Standard	 www.klmtechgroup.com	Page : 1 of 21
		Rev: 01
		April 2011
KLM Technology Group #03-12 Block Aronia, Jalan Sri Perkasa 2 Taman Tampoi Utama 81200 Johor Bahru Malaysia	INTERNALS FOR TOWERS AND DRUMS (PROJECT STANDARDS AND SPECIFICATIONS)	

TABLE OF CONTENT

SCOPE	2
REFERENCES	2
MATERIALS	3
Gasketing	4
Bolting	4
Thermowells	4
DESIGN	4
Loads and Stresses	4
Minimum Metal Thickness and Corrosion Allowance	5
Dimensional Requirements	6
Tray Manways and Access	6
Downcomer Anti-Jump Baffles and Anti-Vortex Baffles	7
Downcomers, Seal Pans, Drawoff Boxes, Accumulator Stacks, Feed Inlets, Reboiler Returns	8
Drain Holes	9
Entrainment Screens	9
Structural	10
FABRICATION	10
Gaskets and Packing	10
Trays	11
Surface Finishing	12
Marking	12
Marking	12
Shop Inspection	12
Leakage and Flow Measurement Tests	13
ADDITIONAL REQUIREMENTS FOR TOWERS AND DRUMS IN WET H₂S SERVICE	13
HANDLING AND STORAGE	14

KLM Technology Group Project Engineering Standard	INTERNALS FOR TOWERS AND DRUMS (PROJECT STANDARDS AND SPECIFICATIONS)	Page 2 of 21
		Rev: 01
		April 2011

SCOPE

This Project Standard and Specification covers the design, fabrication, inspection, testing, handling and storage of trays and other internals for fractionating and extraction towers, separators, drums, and similar vessels.

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. AISC Specification
 - Manual of Steel Construction (ASD) – Specification for Structural Steel Buildings
2. ANSI/ASME Standard
 - B31.3 Chemical Plant and Petroleum Refinery Piping
3. ASME Codes
 - Section VIII Pressure Vessels, Alternative Rules, Division 2
 - Section IX Welding and Brazing Qualifications
4. ASTM Standards
 - A36/A36M 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 and Heat-Resisting Steel Bars and Shapes

KLM Technology Group Project Engineering Standard	INTERNALS FOR TOWERS AND DRUMS	Page 3 of 21
	(PROJECT STANDARDS AND SPECIFICATIONS)	Rev: 01
		April 2011

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
A387/A387M	Pressure Vessel Plates, Alloy Steel, Chromium-Molybdenum
A414/A414M	Carbon Steel Sheet for Pressure Vessels
A569/A569M	Steel, Carbon (0.15 Maximum, Percent) Hot-Rolled and Strip, Commercial Quality
A570/A570M	Hot-Rolled Carbon Steel Sheets and Strip, Structural Quality
A675/A675M	Steel Bars, Carbon, Hot Wrought, Special Quality, Mechanical Properties
B127	Nickel-Copper Alloy (UNS N04400) 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

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

KLM Technology Group Project Engineering Standard	INTERNALS FOR TOWERS AND DRUMS (PROJECT STANDARDS AND SPECIFICATIONS)	Page 4 of 21
		Rev: 01
		April 2011

2. Vendor's proposals to use materials or thicknesses other than those specified shall be submitted to purchaser for approval.
3. When materials are not specified, Vendor's proposals shall be submitted to purchaser for approval by Owner's Engineer.
4. Free machining grades of steel are not permitted, except that Type 416 nuts furnished to ASTM A 194 / A 194M Gr6F with Selenium are acceptable for use with ASTM A 193/A 193M B6 bolts.

Gasketing

Listing tape and washers shall be 1/16 in. (1.5 mm) thick.

Gasket and packing material for other than acid or caustic services shall be an asbestos substitute suitable for the process fluid to which it will be exposed, and for the greater of 1000°F (538°C) or the vessel design temperature.

PTFE impregnated asbestos, or suitable non-asbestos substitute, shall be used in acid or caustic services 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 materials as the internals which they are connecting or which are being connected to support members. However, 12Cr 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).

Thermowells

Materials for thermowells will be specified.

DESIGN

Loads and Stresses

Design loads. Trays, pans, draw-off boxes, or similar internals, shall be designed using a corroded thickness of 0.06 in. (1.5 mm) to support their own weight plus the following live loads at design temperatures:

- a. Fractionating trays. Design live load shall be the greater of 20 psf (98 kg/m²) or the weight of water 2 in. (50 mm) over the highest weir setting. At normal operating tray loadings, the deviation from the horizontal shall not exceed 1/900 of the tower diameter.

KLM Technology Group Project Engineering Standard	INTERNALS FOR TOWERS AND DRUMS	Page 5 of 21
	(PROJECT STANDARDS AND SPECIFICATIONS)	Rev: 01
		April 2011

- b. Areas under downcomers. Design live load shall be the greater of 64 psf (314 kg/m²) or a head of water one-half of the height of the downcomer.
- c. Pans (draw-off and accumulation). Design live load shall be the greater of 1 psi (700 kg/m²) or the weight of water at the maximum operating level of the pan.
- d. Baffles (including shed rows, disc, and donuts) with no normal operating liquid level shall use a design live load of 1 psi (700 kg/m²) on the projected horizontal area.
- e. Entrainment screen components shall be designed for a differential pressure of 0.1 psi (70 kg/m²) unless otherwise specified. The need for a higher differential pressure shall be based on anticipated fouling or upset conditions.

Maintenance loads. Tray support and entrainment screen members (all beams, support clips, etc.), shall be designed for a concentrated live load of 300 lb. (135 kg) at any point on the installed assembly. This design shall be based on the allowable stress at 100°F (38°C) and shall consider the corroded thickness of the support member. For maintenance loads, stresses in the tray plate need not be considered.

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

Failure sequence. Tray assemblies, in so far as possible, shall be designed so that failure will occur in the following order:

- 1st - Tray sections
- 2nd - Minor beams
- 3rd - Major beams (defined as beams 10 ft. (3000 mm) or longer, or beams which extend across a vessel without interruption, regardless of length)

Minimum Metal Thickness and Corrosion Allowance

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.

Supporting members formed as an integral part of the tray deck shall have the same total thickness as the tray.

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

KLM Technology Group Project Engineering Standard	INTERNALS FOR TOWERS AND DRUMS (PROJECT STANDARDS AND SPECIFICATIONS)	Page 6 of 21
		Rev: 01
		April 2011

specified category of VESSEL SHELL CORROSION ALLOWANCE (or METAL LINING OR CLADDING THICKNESS).

Dimensional Requirements

1. The dimensional tolerances on all like parts shall be such as to make the parts interchangeable.
2. All parts which are to be installed after vessel fabrication is complete shall be designed to pass through the manholes provided on the vessel.
3. All parts, except tray manways, shall be designed to permit installation and removal from the top side.
4. The nominal tray diameter shall be determined to the nearest 1/4 in. or 6 mm per the following:
 Tray diameter = Vessel ID – [1% Vessel ID + 3/4 in. (19 mm)]
5. A minimum of 3/4 in. (19 mm) overlap shall be provided between the support ring and the OD of trays, pans and similar items.
6. Bolt hole spacing around the edge of tray sections shall not exceed 7 in. (177 mm).
7. Bolt spacing in downcomers shall not exceed 6 in. (150 mm).
8. Jet trays. Tab dimensions shall be per Figure 1.
9. Bubble cap trays. Cap and chimney dimensions shall be per Figure 2, 3 and 3A. The bubble cap chimney assemblies shall be removable. They shall be held to the tray deck plates by means of individual holdown bolting devices.
10. Cartridge and pedestal trays may be removable from the top only.
11. Maximum unsupported length (minor dimension only) of trays, baffles, and pans shall be 24 in. (600 mm) or as limited by any access manways, whichever is the smaller.

Tray Manways and Access

Access through trays shall be provided as follows:

- a. All trays 3-1/2 ft. (1050 mm) in diameter and larger shall be equipped with manways.
- b. All trays smaller than 3-1/2 ft. in diameter shall be either split or equipped with manways.
- c. Trays having 2 or more liquid passes shall contain manways on each pass.

KLM Technology Group Project Engineering Standard	INTERNALS FOR TOWERS AND DRUMS	Page 7 of 21
	(PROJECT STANDARDS AND SPECIFICATIONS)	Rev: 01
		April 2011

Tray manways shall be as follows:

- a. Tray manways shall provide a minimum rectangular opening of 15 x 18 in. (380 x 460 mm). If necessary, a 13 x 22 in. (330 x 560 mm) rectangular opening can be used.
- b. If opening under or through major support beams is less than those in sub par. a, tray manways shall be installed on both sides of the beam.
- c. Tray manways shall not form a part of the downcomer seal area.
- d. Tray manways shall be vertically aligned, unless otherwise specified.
- e. Tray manways (or tray sections used in lieu of manways in towers 3-1/2 ft. (1050 mm) in diameter or smaller) shall be removable from both above and below the tray.

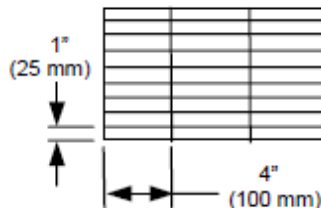
Downcomer Anti-Jump Baffles and Anti-Vortex Baffles

Downcomer anti-jump baffles shall be designed with the following provisions:

- a. Baffles shall extend across the full width of the downcomer and be parallel to the edges of the downcomer.
- b. The bottom edge of the baffle shall be level with the top of the outlet weir (where used) or level with the tray if no weir is used.
- c. Baffles shall contain at least one access way, 22 in. (560 mm) long by the height of the baffle.

Anti-vortex baffles shall be designed and installed per the following criteria:

- a. Acceptable baffle construction: "Subway" grating or panels strip per the configuration shown below; Glitch Grid or Koch Flexigrid panels constructed per these manufacturer's standards.



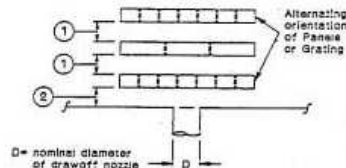
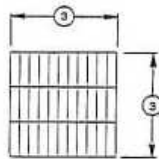
Note:

Fabricated panels shall be constructed using 1 in. x 1/8 in. (25 x 3 mm) strip

KLM Technology Group Project Engineering Standard	INTERNALS FOR TOWERS AND DRUMS (PROJECT STANDARDS AND SPECIFICATIONS)	Page 8 of 21
		Rev: 01
		April 2011

b. Baffle design and installation shall comply with the following:

APPLICATION	VERTICAL DRUMS	BOTTOM DRAWOFFS	HORIZONTAL DRUMS	ACCUMULATOR TRAY DRAW-OFFS	TOWER DRAWOFF BOXES (OTHER THAN ON ACCUMULATOR TRAYS)
CRITICAL DIMENSIONS					
Number of Tiers	3	3	3	3	
① Spacing between Tiers	6 in. (150 mm) max. Tiers to be equally spaced and located between the drawoff nozzle D and the low liquid level. Distance from top tier to low liquid level shall be minimized within the above constraints.				* will be specified
② Clearance between bottom of Tiers and Outlet Nozzle	D/2, or greater as required to accommodate baffle size		2 in. (50 mm) approx.		
③ Baffle size (length of sides)	4D or 1/2 Drum (tower) diameter, whichever is the smaller value				



Downcomers, Seal Pans, Drawoff Boxes, Accumulator Stacks, Feed Inlets, Reboiler Returns

Downcomers shall be installed with bolted joints, and shall be designed so that no vapor bypassing will occur. Stiffeners must be provided as needed to limit the horizontal movement of the bottom edge of the downcomer at any point to + 1/4 in. (± 6 mm).

All joints in areas under downcomers, including the joint to the tray support ring, shall be continuously seal welded after installation of the tray. The joint with the contacting area of the tray shall not be welded. Bolted and gasketed construction shall not be used in areas under downcomers except in towers 3 ft. (900 mm) in diameter and smaller, where removal of the downcomer seal area is required to permit access.

All joints in pans and drawoff boxes, shall have continuous welds to prevent leakage.

Accumulator stacks on drawoff pans shall be seal welded to the pans. Any joints in the stacks shall be seal welded.

Feed inlets and reboiler returns. Where a stream enters a vessel, the stream shall impinge on a smooth, unobstructed surface regardless of whether it discharges against a downcomer apron or a specially provided baffle.

KLM Technology Group Project Engineering Standard	INTERNALS FOR TOWERS AND DRUMS (PROJECT STANDARDS AND SPECIFICATIONS)	Page 9 of 21
		Rev: 01
		April 2011

Trough type distributors which are hung by a bolt/nut arrangement (rather than supported from below by a tray support ring or truss) shall be provided with lock washers or lock nuts.

Drain Holes

Drain holes 1/2 in. (13 mm) in diameter shall be provided as follows:

- a. One hole in each tray recessed seal pan.
- b. One hole per 5 ft. (1500 mm) of length in the base of each inlet weir.
- c. For bubble cap trays, provide one hole per 5 ft. (1500 mm) of length in the base of each outlet weir.
- d. Holes shall be located downstream of downcomer apron to prevent vapor from rising through downcomer liquid.
- e. All boxes and pans from which liquid is normally withdrawn shall be equipped with nozzle(s) that will insure complete drainage of the box or pan. Drain holes shall not be provided in water drawoff boxes.
- f. One hole in each distributor pipe where the process fluid does not discharge vertically downward.

Entrainment Screens

Crinkled wire mesh entrainment screens (CWMS) shall meet the following requirements:

- a. They shall be of the sandwich type consisting of entrainment mesh, retained between welded grid supports held apart by spacer rods passing through the mesh or by formed straps, welded to the top and bottom grids.
- b. Materials of the supports, rods, or straps shall be at least equivalent in terms of corrosion resistance to that of the other vessel internals.
- c. Support and holddown grids shall have maximum sized openings of 6" x 6" (150 x 150 mm).
- d. Spacer rods shall be 1/4 in. (6 mm) diameter, and located on a maximum spacing of 18 in. (450 mm).
- e. The screen assembly shall be attached to the support beams at a minimum of four (4) points with 1/2 in. (12 mm) minimum diameter J-bolts with locknuts.

Mesh shall be 6 in. (150 mm) thick and knitted from 0.012 ± .002 in. (0.305 ± .051 mm) diameter wire. Material shall be Type 304 stainless steel, Monel, or Inconel 600. Mesh weight shall be 5 to 10.0 lb/cu. ft. (80 to 160 kg/m³).

Proposals to use plastic mesh (e.g. polypropylene or polyethylene) shall be submitted to purchaser for approval by Owner's Engineer.