

DEP SPECIFICATION

INTERNALS FOR COLUMNS

DEP 31.20.20.31-Gen.

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DESIGN AND ENGINEERING PRACTICE



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1. INTRODUCTION

1.1 SCOPE

This DEP specifies requirements and gives recommendations for the design, fabrication and shop testing of column internals. For field inspection, refer to DEP 61.10.08.11-Gen.

In this DEP, Shell Calming Section™ Trays, Shell HiFi™ Trays, Shell ConSep™ Trays, Shell Swirl Tube™ Trays and Shell Schoepentoeter™ (which is strictly the correct usage in publications) are, for convenience, referred to without the Shell prefix or ™ suffix. These are all Shell GSI proprietary internals and may be manufactured only by manufacturers that have been granted permission to do so by Shell GSI.

The downcomers for Calming Section trays and HiFi trays are referred to as Calming Sections and HiFi Calming Sections, respectively.

The following types of **trays** are covered:

- a) bubble cap trays;
- b) grid trays;
- c) sieve trays;
- d) valve trays;
- e) conventional downcomer trays;
- f) Calming Section trays;
- g) HiFi trays;
- h) ConSep trays;
- i) Swirl Tube trays;

The following **separator internals** are covered:

- Separation Swirl Tube decks
- Wiremesh demisters

The following types of **liquid collectors** are covered:

- partial draw-off trays;
- total draw-off trays;
- chimney trays;
- gutter arrangements above a bottom compartment;
- vane collectors.

The following **packing internals** are covered:

- structured packing;
- random packing;
- support grids;
- hold-down grids (bed limiter).

The following **feed inlet devices** are covered:

- a) liquid gravity distributors;
- b) liquid elbows;
- c) spray-nozzles;
- d) half-open pipes;
- e) Schoepentoeters;
- f) HiFi Schoepentoeters.

This DEP is a revision of the DEP of the same number dated January 2009; see (1.5) regarding the changes.

1.2 DISTRIBUTION, INTENDED USE AND REGULATORY CONSIDERATIONS

Unless otherwise authorised by Shell GSI, the distribution of this DEP is confined to Shell companies and, where necessary, to Contractors and Manufacturers/Suppliers nominated by them. Any authorised access to DEPs does not for that reason constitute an authorisation to any documents, data or information to which the DEPs may refer.

This DEP is intended for use in oil refineries, chemical plants and gas plants. This DEP may also be applied in other similar facilities.

When DEPs are applied, a Management of Change (MOC) process shall be implemented; this is of particular importance when existing facilities are to be modified.

If national and/or local regulations exist in which some of the requirements could be more stringent than in this DEP, the Contractor shall determine by careful scrutiny which of the requirements are the more stringent and which combination of requirements will be acceptable with regard to the safety, environmental, economic and legal aspects. In all cases the Contractor shall inform the Principal of any deviation from the requirements of this DEP which is considered to be necessary in order to comply with national and/or local regulations. The Principal may then negotiate with the Authorities concerned, the objective being to obtain agreement to follow this DEP as closely as possible.

1.3 DEFINITIONS

1.3.1 General definitions

The **Contractor** is the party that carries out all or part of the design, engineering, procurement, construction, commissioning or management of a project or operation of a facility. The Principal may undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party that manufactures or supplies equipment and services to perform the duties specified by the Contractor.

The **Principal** is the party that initiates the project and ultimately pays for it. The Principal may also include an agent or consultant authorised to act for, and on behalf of, the Principal.

The word **shall** indicates a requirement.

The word **should** indicates a recommendation.

1.3.2 Abbreviations

Term	Definition
NFA	Net Free Area
HiFi	High Flow parameter
lbf	pound-force
N	Newton
SMS(M)	Schoepentoeter - Mist mat - Swirldack ([secondary] mist mat separator)

1.4 CROSS-REFERENCES

Where cross-references to other parts of this DEP are made, the referenced section number is shown in brackets (). Other documents referenced by this DEP are listed in (7).

1.5 SUMMARY OF MAIN CHANGES

This DEP is a revision of the DEP of the same number dated January 2009. The following are the main, non-editorial, changes.

Old section	New section	Change
2.4	2.4	Requirements for additional manways changed
3.2.1	3.2.1	Tray load criteria changed
3.2.2	3.2.2	Text revised. Criteria not changed
3.3.1	3.3.1	Diameter drainhole in calming section sealpans increased
3.4.2	3.4.2	Bolting of tray panels preferred above wedge/clamp connection. The latter not allowed for column diameters < 1500 mm. Snap in valves banned. The use of standard flanges for spray headers mandatory.
3.6.1	3.6.1	Requirement for maximum panel length removed
3.6.3.	3.6.3	Requirement for drainholes in sealpan bottom CD tray added
3.6.4	3.6.4	Max. load, leak tightness and deflection criteria for Consep trays added
3.6.5	3.6.5	Max. load, leak tightness and deflection criteria for Swirl tube trays added
3.6.6	3.6.6	Max load criteria added
3.6.7.1	3.6.7.1	Requirements for manufacturing mistmats changed,
	3.6.7.2	Max upward load criterion Mist mats added
4.1	4.1	Required open area for vapour flow changed
4.2.5	4.2.5	Requirements for gasketing changed
4.6.6	4.6.6	Hydraulic testing of gravity distributors made mandatory
5.3.1	5.3.1	Max load criteria packing changed. Heavy duty criterion added
5.7.2	5.7.2	Filling procedure for dumped packings changed
6.9.2	6.9.2	The use of standard flanges for spray headers mandatory
App XI.2.2	App XI.2.2	Design method for Schoepentoeters with Rv=300 mm changed
App XII	App XII	Leak test requirement changed to 25 mm/20 minutes

1.6 COMMENTS ON THIS DEP

Comments on this DEP may be sent to the Administrator at standards@shell.com, using the DEP Feedback Form. The DEP Feedback Form can be found on the main page of "DEPs on the Web", available through the Global Technical Standards web portal <http://www.shell.com/standards> and on the main page of the DEPs DVD-ROM.

1.7 DUAL UNITS

This DEP contains both the International System (SI) units, as well as the corresponding US Customary (USC) units, which are given following the SI units in brackets. When agreed by the Principal, the indicated USC values/units may be used.

2. GENERAL

2.1 GENERAL REQUIREMENTS

To further specify the design, the Manufacturer should normally receive data/requisition sheets or an order giving all the information and design data together with lay-out drawings, e.g., showing feed and draw-off nozzle orientation, manhole position, etc., if these are required.

The Manufacturer's drawings shall be submitted to the Principal for approval and shall show all constructional details, including downcomer and tray panel fastenings and the location, size and fastening of manholes and distributor supports.

The internals Supplier shall be responsible for ensuring that the mechanical design of the internals, including their supports, is satisfactory for the design conditions indicated on the requisition and/or drawings. The internals Supplier shall make his own calculations, for which he is fully responsible. However, the requirements specified in the order and requisition shall prevail if more stringent.

2.2 NET FREE (OPEN) AREA

The Net Free Area (NFA) of a column internal is the ratio of the total hole area (for vapour passage) to the column's cross-sectional area expressed as a percentage. The maximum allowable deviation of the NFA shall be plus or minus 0.5 % of the column's cross section, or plus or minus 5.0 % of the stated NFA, whichever is the smaller.

2.3 COLUMN ATTACHMENTS

Column attachments such as support rings, support lugs and drip rings shall be designed by the internals Supplier but shall be supplied and installed by the column Manufacturer. To this end, the internals Supplier shall supply the column internal attachment drawings in sufficient time to enable the column Manufacturer to meet the delivery date. The column Manufacturer should make drawings of attachments that are welded to the column. Drawings of attachments that are bolted to the column wall should be drawn by the internals Supplier.

Each internal part connected to a column attachment or the column wall (support beam, Schoepentoeter, tray, etc.) should have a connection suitable for the expected thermal expansion, e.g., bolted connections should be applied with a slotted hole. The location and type of connection shall be determined by the internals Supplier.

Column internals shall be fastened to support rings and beams in such a way that they can be easily mounted and dismantled.

For maintenance or debottlenecking purposes only, the Principal shall be allowed to provide Subcontractors and equipment Suppliers construction details of attachments welded to the column wall without breaching any technology secrecy or non-use agreements.

2.4 ACCESS TO THE COLUMN FOR INSTALLATION AND REMOVAL

A manhole in the top column shell ring, a blind flange or a flanged head should be provided to allow column internals to be installed and removed. For columns with a diameter larger than 2.0 m (6 ft – 6 in), a top dome with a top flange should be considered. For columns with a diameter between 1.0 m (3 ft – 3 in) and 2.0 m (6 ft – 6 in), the most economical of the two options should be chosen. A top dome should have a diameter of at least 1.0 m (3 ft – 3 in), but no more than 1.5 m (5 ft) or half the column diameter. The height of a top dome shall be at least twice the top dome diameter. The column should be accessed via a manhole in the top column shell ring.

Manholes should be provided for the installation and access of other column internals. The internal diameter of manholes should be at least 610 mm (24 in), but in any case shall not be less than 460 mm (18 in).

To facilitate access to the column internals, column manholes should be located as follows:
One manway should be located 900 mm (36 in) above the bottom head seam and another manway should be 450 mm (18 in) above the top tray if there is no top flange or top dome.

Additional manways should be installed as follows:

- a) For Column diameter < 2.0 m (6.6 ft), manways spaced every 30 trays
- b) For 2.0 m (6.6 ft) < Column diameter < 4.0 m (13.1 ft), manways spaced every 20 trays
- c) For Column diameter > 4.0 m (13.1 ft), manways spaced every 15 trays
- d) Vessels with internal compartments or with components obstructing egress from one section to another should have a manway in each section.
- e) In close proximity to the Schoepentoeter or half-open pipe or a spray distributor so that safe access can be gained to the internals
- f) Above a feed tray
- g) Above a gravity liquid distributor
- h) Below draw-off trays
- i) In the flash zone

Internal access to manways shall be taken into consideration: provisions such as hand grips or stair cages shall be provided as needed depending on the level of the tray versus the location of the manway

The clearance between the manhole and a column shell weld should be at least 150 mm (6 in).

The internals Supplier shall verify that the manholes and top flange or top dome necessary for the safe installation of the column internals will be provided on the column.

2.5 MATERIALS OF CONSTRUCTION

Materials of construction shall be as specified on the data/requisition sheet or in the order.

Corrosion allowance, if any, shall be as specified on the data/requisition sheet or in the order.

Gaskets for sealing of column internals, if required, shall be specified on the data/requisition sheet. Gaskets are tape or braided rope fabricated from asbestos-free material suitable for the processing environment. The minimum thickness of gasket tape shall be 1.5 mm (1/16 in).

Gasket material shall be used for internal flange connections and Bubble Cap gaskets (if applicable). A list of typical gasket material is specified as follows:

- a) Polytetrafluoroethylene (PTFE)
- b) Fibreglass
- c) Graphite
- d) Aramid
- e) Teflon®
- f) Graphite filled (spiral wound, Camprofile)

Rubber-impregnated glass fibre rope should not be used.

2.6 SPARES FOR ERECTION

DEP 70.10.90.11-Gen. shall apply. The Manufacturer shall ensure that sufficient spare parts are available during erection. The Principal shall authorize any undercutting of

indicated contingencies. As a general guide, 5 % extra material may be specified as a contingency for the following component parts of each size and type:

- valves, bolts, nuts, clamps, wedges, washers, etc., with not less than 4 pieces;
- jointing materials, e.g., gaskets, packing, etc., with not less than 1 piece.

2.7 WELDING

Any welding on column internal parts shall be performed by qualified welders in accordance with the applicable pressure vessel code.

The welding of column internal support rings and attachments to the wall of a new column shall be the responsibility of the column Manufacturer.

2.8 BOLTS

Alloy steel bolts shall be not smaller than 10 mm (3/8 in) diameter and carbon steel bolts shall be not smaller than 12 mm (1/2 in) diameter. Bolt threads shall be metric in accordance with the relevant ISO standard unless otherwise specified on the data/requisition sheet or order. Bolt length should be chosen so that after the nut(s) have been tightened, only 2 to 3 threads are exposed. If shims are applied for levelling, threading may be longer to cover the complete shim range.

3. FRACTIONATING TRAYS

3.1 PERFORATIONS AND VALVES

Fractionating tray perforations and valves (floating and fixed) shall be as evenly spaced as practicable. The perforating pattern should be rectangular or triangular at the internals Supplier's discretion but shall be approved by the Principal. There should always be a minimum of two rows of perforations (sieve holes or valves) between the bottom of the downcomer and the outlet weir of the tray below. The triangular pattern should be specified so that liquid bypassing is minimised which means that the base of the triangle is perpendicular to the flow direction.

Punched fractionating sieve tray perforations shall be burr side up, except that:

- the holes for Shell Snap-in valves shall be burr side down to facilitate mounting the valves;
- the punch direction for (R)V1 valves or equivalent may be burr side up or burr side down.

Protruded holes shall only be used if specified in the data/requisition sheet. The bubbling area underneath the Calming Section discharge slots of a HiFi tray shall not be perforated with sieve holes. For Fixed and Floating Valves, the whole tray panel shall be perforated unless specified differently on the data/requisition sheet.

Fixed or floating valves can be used for Calming Section valve, HiFi valve, and conventional downcomer valve trays. The type and number of valves and the orientation (if applicable) shall be specified on the data/requisition sheet and shall be confirmed with the Principal if trays operate beyond 90% of Max Useful Capacity

The pitch of Shell Snap-in or other floating valves (measured centre to centre) shall be not less than 1.5 times the diameter of the valve cap. For some valve types, the diameter of the valve cap is larger than the diameter of the hole in the tray.

The following guidelines for perforation of HiFi tray panels apply

- a) Tray panels (fixed and floating valves) shall be fully perforated, also below the downcomers and downcomer slots, unless specified differently on the equipment datasheets.
- b) For sieve trays perforating below the downcomer slots is not allowed
- c) Distance of centre of first row of holes (sieves, floating valves only) to the outlet weir shall be minimized.
- d) If not perforated below the downcomers or slots, the distance of the centre of the first row of holes from the vertical projection of the Calming Section slots or downcomer bottom at the tray below shall be $\frac{1}{2}$ pitch of that tray in which the pitch is defined as the distance between the perforations perpendicular to the Calming Section outlet weir.

3.2 MECHANICAL REQUIREMENTS

3.2.1 Loads

Unless otherwise stated on the data/requisition sheet or in the order, fractionating trays and supports shall be designed to withstand the following forces:

For normal service:

- For Calming Section Trays: a maximum downward operating load equal to the weight of liquid (equivalent to a height of the weir + 50 mm (2 in) + liquid full downcomers ($= 0.75 \times CSA \times CSH$), with a minimum of 1000 Pa (0.15 psi).
- For Conventional Downcomer Trays: a maximum downward operating load equal to the weight of liquid (equivalent to a height of the weir + 50 mm (2 in) +

downcomers filled with water up to 50% of TS, with a minimum of 1000 Pa (0.15 psi).

- A maximum upward load of 2000 Pa (0.30 psi) at maximum working temperature evenly distributed over the entire fractionating tray surface.

Tray assemblies shall be capable of supporting their own weight plus a concentrated load of 1350 N (300 lbf) located at any trusses on the tray at ambient temperature. The maximum allowable stress permitted under this condition is at ambient temperature.

For heavy duty:

In cases where the loads specified above can easily be exceeded due to an operational mishap, e.g., liquid-full trays, steam explosions etc., more stringent load criteria shall apply. In these cases the following maximum loads should be used.

Downward: The weight of the hot process liquid if the tray spacing is completely filled.

Upward: 6900 Pa (1 psi) maximum. Although damage cannot be avoided in this case, tray panels shall be clamped onto the supports. Hoke bolts (C bolts) or hoke clamps (in combination with type II support ring) shall be used to minimize damage to support beams and rings. As an alternative, the use of one or more explosion doors may be considered. Size is typically 80 % of the total hole area for vapour passage with a minimum of 5 % of the active tray area. There should be at least one door per beam area. Explosion doors are only used in combination with a high uplift design of 6900 m² (145 lbf/ft²).

Criteria for the design of internals for these heavy-duty conditions shall be indicated on the data requisition sheets.

Dedicated load criteria are used for the special, high capacity, trays and separator internals. These are given in the subsequent sections (3.6.4) through (3.6.7).

3.2.2 Deflections

For sieve, valve, bubble cap and grid trays the maximum downward or upward deflection when operated within their normal operating window shall not be more than 1/800 of the internal column diameter, with a maximum of 6 mm (1/4 in). At the maximum operating load (refer to (3.2.1)), no permanent deformation and/or damage shall occur

3.2.3 Levelness

The tilt of fractionating trays and gravity liquid distributors shall not exceed 0.3 % of the column diameter, or 6 mm (1/4 in), whichever is the smaller. Local depressions and bulges in panels shall not exceed 6 mm (1/4 in) from the nominal plane. The tolerances of the support rings inside the vessel and the proper erection of the vessel on site largely determine the levelness of trays. Refer to DEP 31.22.10.32-Gen. or DEP 31.22.20.31-Gen. for tolerances.

3.2.4 Fractionating tray supports

3.2.4.1 Rings

Stacked trays (or cartridge trays) should be installed in columns with a nominal diameter of up to 800 mm (32 in).

For columns with a nominal diameter of 800 mm (32 in) and above, support rings shall be welded to the column wall, see (5.3.4).

For support rings, reference is made to (Appendix IV).

A minimum of overlap (C) between tray panels and support ring is required. Refer to (Appendix IV) for details.

3.2.4.2 Panel supports

The panels of Calming Section trays shall be self-supporting. The height of reinforcement rims shall not exceed one-quarter of the tray spacing for panels that are perpendicular to

the liquid flow; this may be increased to one-third of the tray spacing for panels that are parallel to the liquid flow direction.

3.2.4.3 Beams

Minimum material thickness shall be 3 mm (1/8 in).

To accommodate thermal expansion, slotted holes shall be used for mounting the beams onto the supports. The Manufacturer/Supplier of the internals shall specify the slot length on the basis of transient conditions, i.e., the maximum temperature difference that can occur between the column shell and the internals during startup or turndown. Unless otherwise specified, the difference between the maximum operating temperature and ambient shall be used for that calculation.

Support beams shall not restrict the liquid and vapour communication on the trays. The total height of any support beam shall be minimised on the basis of economic considerations.

On trays equipped with conventional downcomers, the main support beams shall be parallel to the direction of liquid flow.

For minor support beams on conventional downcomer trays, where beams are perpendicular to the direction of liquid flow, and for the main beams on Calming Section and HiFi trays, the following shall apply:

The beam shall occupy not more than one third of the space between the trays, as defined by:

$$A_{\text{beam}}/(D \times TS) < 1/3$$

where:

A_{beam} = area of beam, horizontally projected, m² (ft²);

D = internal diameter of column, m (ft);

TS = tray spacing, m (ft).

If this criterion cannot be met with a solid beam, an open type of beam shall be used, such as an I-type beam with holes therein or an open work construction as shown in (Appendix III).

If a C-type beam with separation segments is used, each segment of the beam should be provided with a draining facility. Where draining of the segment is not possible, a drain hole of at least 12 mm (1/2 in) should be drilled in the bottom of the beam.

Unless otherwise specified in the requisition, the number of tray support beams for Calming Section trays, as presented in Table 3.1, may be used as a general guide.

Table 3.1 Number of tray support beams for Calming Section trays

Column diameter, D_c [m]	Column diameter, D_c [ft]	Number of beams
< 2.5	< 8.2	0
$2.5 \leq D_c < 5.2$	$8.2 \leq D_c < 17.1$	1
$5.2 \leq D_c \leq 7.8$	$17.1 \leq D_c \leq 25.6$	2
$D_c > 7.8$	$D_c > 25.6$	3

HiFi trays up to a diameter of 8 m (26 ft) will normally have one central support beam. For a column diameter < 3 m (10 ft), a support beam is only needed if mechanical strength requirements cannot otherwise be met. For columns with a larger diameter, the Principal should be consulted if no details on the HiFi tray support beams are specified in the requisition.

If beneficial, a combined beam (for two fractionating trays) may be fitted. In this case, the height of the support beam is equal to the tray spacing. If required, and if approved by the Principal, combined beams may also be applied for column diameters smaller than 6.0 m (20 ft).

If a combined beam is used, it shall occupy not more than 1/3 of the free space. Furthermore, the height of the edge/obstruction below the support beam openings ("Hb" in Figure 3.1) should be less than the weir height of the tray below; in any case, Hb shall not exceed a height of 35 mm (1-3/8 in) so as not to hamper the liquid cross-flow on that tray. The Principal shall be consulted if these requirements cannot be met.

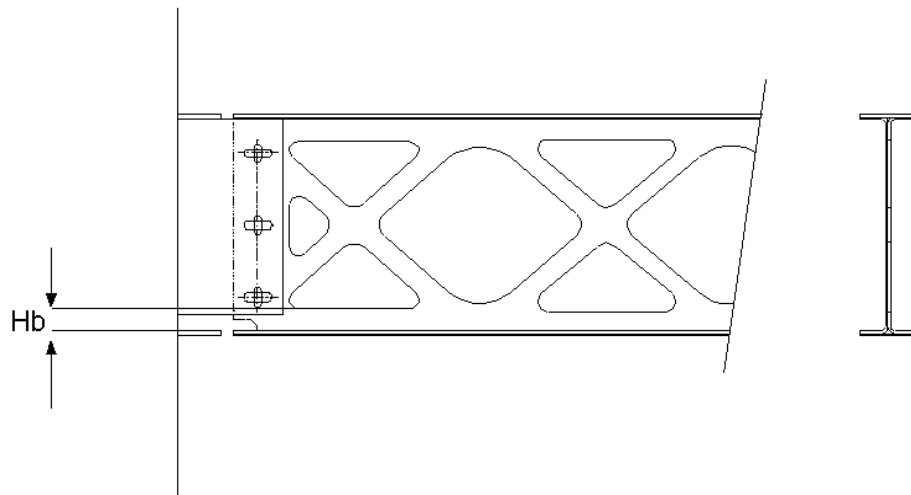


Figure 3.1 Open structure combined support beam

3.3 DRAINING AND LEAKAGE

3.3.1 Draining

Except for trays with seal pans or inlet weirs, drain holes are not required on sieve or valve trays. Each seal pan should have at least one drain hole with a diameter of 10 mm (3/8 in) to permit draining of the liquid hold-up. Drain holes in recessed seal pans shall be located downstream or on the tray side of the downcomer so that any vapour passing through the holes will not by-pass the tray above. Inlet weirs shall have a 13 mm (1/2 in) hole at the base to drain into the tray. Seal pans underneath Calming Sections shall have a drain hole of 12 mm (1/2 in) diameter.

3.3.2 Leak tightness

The tightness of Calming Sections and conventional downcomers shall be as specified in (3.6.1). Bubble cap trays should be able to hold liquid up to weir or riser height and therefore, should be capable of passing the leakage test as described in (Appendix XII).

3.4 INSTALLATION, REMOVAL AND ASSEMBLY

3.4.1 Fractionating tray installation and removal

To facilitate installation and maintenance, fractionating trays shall be made in sections which shall pass through manholes or the top dome of the column.

Stacked trays shall be designed to permit installation and removal from above.

Unless otherwise specified, all fractionating trays shall be designed to permit installation and removal from the top.

All parts shall have durable markings, in paint or ink, relating to the erection plan from which the internals can be unmistakably identified. For stainless steel parts, the paint or ink shall be chloride-free. See DEP 30.48.00.31-Gen.

3.4.2 Fractionating tray assembly

Parts should be made as large as possible in order to reduce the number of joints.

For mechanical fastening, bolts and quick fasteners (wedge/clamps) are allowed. Bolted connections are preferred for the sake of standardization. Wedge/clamp style fasteners should only be used for larger column diameters [> 1.5 m (5 ft)], if there is a particular reason for a given application (fouling/corrosion/exotic materials), or for replacement of parts in-kind. Note also that bolted joints are preferred for panels with fixed valves. Sufficient clearance to facilitate assembly on site shall be allowed.

Bolted joints shall be used to attach support beams to cleats, to attach downcomer plates in columns with conventional downcomers, and to attach auxiliary internals.

Connections to beams or cleats that are essential to the integrity of the column internal construction shall be secured. Bolted connections shall be secured by means of tack welding the nut to the bolt, or by employing a second nut.

The maximum allowable difference in level between two adjacent panels shall be 2 mm (0.08 in). For grid trays the maximum allowable vertical displacement of adjoining bars shall be 3 mm (1/8 in).

Internal distribution pipes shall have flanged connections, refer to Standard Drawing S 10.016. Indicated flange thicknesses should be used as a guideline only and may be minimised for all nominal pipe sizes on the basis of mechanical requirements and the materials of construction. For spray headers, standard flanges (Sch 10S) shall be used

For floating valve trays, round and rectangular valves should be used. Shell Snap-in valve shall not be used due to the high risk of mechanical damage; in any case, they may be used only if specified on the data/requisition sheets.

For (tray panel) replacement jobs, it is also recommended to replace snap in valves by RV1 valves or equivalent. In that case, the Net Free area shall be changed to keep the dry pressure drop, capacity and turndown of the trays the same. This shall be approved by the Principal.

If Snap in valves are used the following shall be noticed:

- a) To prevent mechanical damage, Shell Snap-in valves shall not be mounted on trays until the trays have been installed in the column.
- b) Snap-in valves shall be inserted by the application of even pressure by a hand on a valve placed squarely in the tray hole.
- c) Snap-in valves shall not be driven in by a hammer, mallet or other blunt instrument.
- d) Damaged Shell Snap-in valves shall be discarded and replaced by new ones.
- e) Valves shall not be re-used because the legs may have been overstressed and may have lost their resilience.

3.5 PROVISIONS FOR ACCESS

Fractionating trays and fittings shall be designed so that the tray is easily accessible for cleaning, gas freeing, inspection and maintenance.

Access to fractionating trays not served by column manways shall be provided by means of bolted manways in the trays.

The column Manufacturer shall ensure that a man can pass through the manways of the fractionating trays as installed.

Whenever possible, tray manways shall have a minimum opening of 320 mm x 500 mm (13 in x 20 in). Where this is impossible for construction reasons, the use of smaller manways shall be subject to the approval of the Principal. If no manway is possible, the cover plate of the tray shall be split.

If the clearance between the tray deck and the bottom of the main supporting beams of the tray above is less than 400 mm (16 in), tray manways shall be installed on each side of the beams.

For HiFi trays, the Manufacturer shall ensure suitable access to the tray below on both sides of the beam.

On Calming Section trays, manways are preferably not located directly underneath Calming Sections of the tray above. Where this is unavoidable, the column Manufacturer shall check whether it is necessary for part or all of a Calming Section or baffle to be made removable.

For the sake of flexibility, bolting and unbolting of tray manways should be possible from both sides of the tray. If access from one side is impossible, e.g., in the case of small-diameter HiFi trays, this requirement may be relaxed if approved by the Principal.

Exposed edges of trays at locations where people may have access shall be bevelled or rounded off, e.g., at manways and top edges of weirs.

3.6 SPECIFIC TYPES OF FRACTIONATING TRAYS

3.6.1 Calming Section trays

Calming Sections shall be manufactured in one piece, as shown in (Appendix I), unless a division is needed due to column manhole restraints. They shall be evenly distributed on the tray as specified in the requisition and/or drawing. Minimum material thickness of the tray panels shall be 2 mm (0.08 in) and no parts of the tray shall have a material thickness of less than 1.5 mm (1/16 in). Minimum lateral distance between two adjacent Calming Sections shall be 420 mm (17 in) (centre to centre).

A minimum of two rows of perforations shall be included between adjacent Calming Sections.

Calming Sections shall have a box-type construction as illustrated in (Appendix I). The following tolerances shall apply:

Length at top of weir	±	5 mm (0.2 in);
Width at top of weir	+	5 mm (0.2 in);
	–	0 mm (0 in);
Height of weir above tray	±	2 mm (0.08 in);
Height of baffle above tray	±	10 mm (3/8 in);
Depth below tray	±	5 mm (0.2 in);
Length at bottom	±	10 mm (3/8 in);
Width at bottom	±	5 mm (0.2 in);
Seal pan depth/clearance	+	5 mm (0.2 in);
	–	0 mm (0 in).

The following tolerances on the area indicated are allowed:

Slot area	+	10 %;
Calming Section area	+	10 %;

The space for fastening the downcomer to the tray panel, between the ends of the downcomer and the tray support ring, shall be 15 mm (5/8 in) maximum.

In principle, the Calming Section discharges liquid only through the slots or seal pan provided for that purpose. The total area of openings elsewhere in the Calming Section that may lead to leakage of liquid or vapour shall not exceed 1.0 % of the open area in the downcomer bottom. Any gap in a seam shall not be wider than 1.0 mm. (0.04 in).

3.6.2 HiFi trays

HiFi Calming Sections shall be manufactured in one piece, as shown in (Appendix II), unless a division is needed due to column manhole restraints. Tolerances on the main dimensions and the requirements for leak tightness are as described in (3.6.1). Minimum material thickness of the tray panels shall be 2 mm (0.08 in) and no parts of the tray shall have a material thickness of less than 1.5 mm (1/16 in).

Baffles are fitted to all except the corner downcomers. Vertical plates shall support the baffles. If the baffles are not connected to the HiFi Calming Section ends, the first baffle support (nearest to the HiFi support beam) shall be placed 100 mm (4 in) from the Calming Section end. The last baffle support (closest to the column wall) shall be positioned 100 mm (4 in) from the end of the smaller of the two long sides of the HiFi Calming Section. These two outer baffle supports shall have a clearance of 200 mm (8 in) from the bottom of the HiFi Calming Section.

Subsequently, a minimum of intermediate baffle supports should be spaced at maximum 600 mm (24 in) intervals extending to 100 mm (4 in) above the Calming Section bottom. Baffle supports shall be placed so that the number of slots or slot groups in between baffles is the same.

The maximum space between the ends of the HiFi Calming Sections and the support ring or beam for fastening shall be:

- 10 mm (3/8 in) to the edge of the beam;
- 20 mm (3/4 in) to the edge of the support ring.

If no central support beam is used, the minimum distance between the end of the HiFi Calming Section and the column centreline shall be 50 mm (2 in).

On single downcomer HiFi trays installed in small columns with a diameter ≤ 1.5 m (5 ft), one HiFi-like segmental downcomer shall be installed per tray. As sealing against the column wall is difficult, this segmental downcomer shall be constructed as a segmental box. The box shall have a clearance of minimum 15 mm (5/8 in) from the column wall. In columns with a diameter ≤ 800 mm (32 in) where accessibility is difficult, a full (expandable) support ring with a width of 15 mm (5/8 in) shall be used. For larger diameter columns, the width of the tray support ring at the location of the segmental downcomer shall be reduced to 15 mm (5/8 in).

3.6.3 Conventional downcomer trays

Minimum material thickness of the tray panels shall be 2 mm (0.08 in) and no parts of the tray shall have a material thickness of less than 1.5 mm (1/16 in). Tolerances on the main dimensions and the requirements for leak tightness are as described in (3.6.1).

The sealpan of the downcomer of the bottom tray often acts as a trap for debris. Therefore, the use of one or more larger drainhole(s) of 25 mm (1 in) is recommended as long as the downcomer leak tightness criterion as specified in (3.6.1) (total downcomer leak $< 1\%$ of downcomer open bottom area) is not violated.

3.6.4 ConSep trays

The ConSep tubes shall be tack welded to the swirler which shall be tack welded to the ConSep swirl deck. Tolerances on the main dimensions and the requirements for leak tightness are as described in (3.6.1). The bottom plate of the swirl tube box and the vertical walls shall be fully seal welded. The box flanges and the swirl deck downcomer flanges shall be provided with gaskets. Total leak area of the ConSep box shall be less than 15 mm² per swirltube installed.

Different mechanical load and installation criteria apply:

- A maximum downward operating load equal to the weight of liquid (equivalent to a height of the weir + 50 mm (2 inch) + liquid full downcomers ($= 0.75 \times \text{CSA} \times \text{CSH}$), with a minimum of 1000 Pa (0.15 psi).
- A maximum upward load of 6900 Pa (1 psi) at maximum working temperature evenly distributed over the entire fractionating tray surface
- Tray assemblies shall be capable of supporting their own weight plus a concentrated load of 1350 N (300 lbf) located at any trusses on the tray at ambient temperature. The maximum allowable stress permitted under this condition is at ambient temperature.

Deflection criteria as defined in (3.2.2) apply. Special flagbolts shall be used to install the trays onto the support rings since the trays are only accessible from one side and interference with the ConSep box and the support ring shall be avoided.

3.6.5 Contacting Swirl Tube trays

Contacting Swirl Tube trays and tray panels shall be leak tight installed on the (expandable) tray support rings. Prefabricated gaskets shall be used on the tray support ring and in between the tray panel flanges. The gasket material shall be specified in the data/requisition sheets. The flanges of the liquid feed and outlet pipes shall be provided with prefabricated gaskets to ensure leak tight installation.

If expandable tray support rings are used, two sealing methods are available.

The preferred method is to use a braided ceramic rope enclosed in a chamber, as illustrated in Figure 3.2.

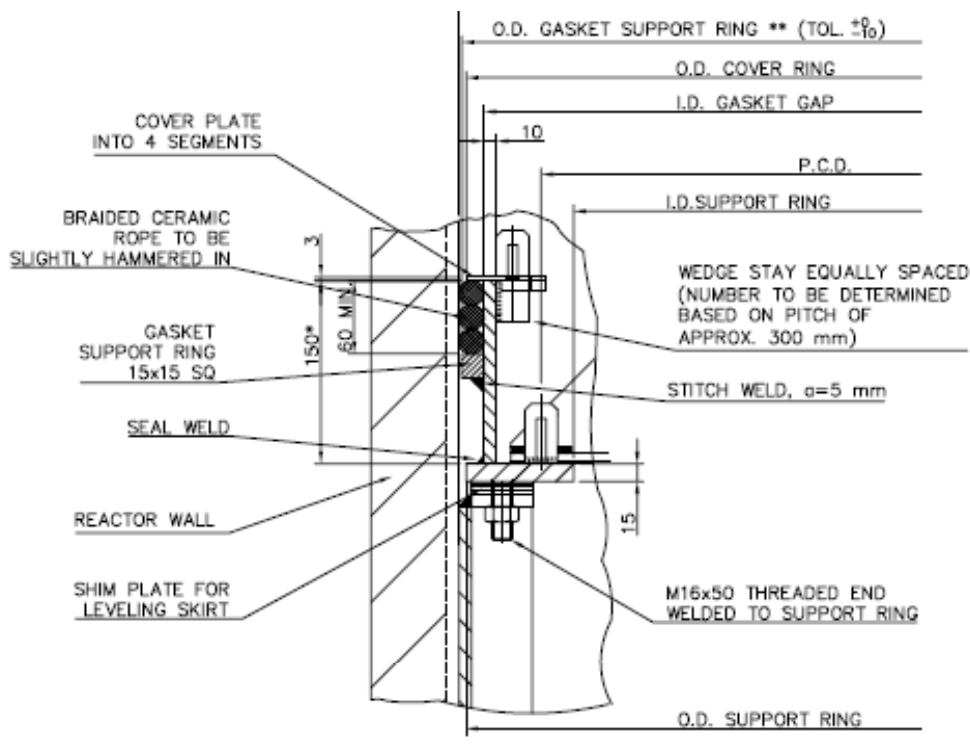


Figure 3.2 Sealing of tray onto expandable support ring

As an alternative, an O-ring may be used to make a seal against the wall. The O-ring shall be prefabricated and made out of one piece. The O-ring material shall be resistant against the medium used and be specified in the data/requisition sheet. A typical material example is Viton GF 75 applied in glycol contactors, which is resistant against condensate. All support ring divisions shall be provided with closing plates for maximum leak tightness.