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1 Subject of specification

This specification and other documents referenced herein establish the minimum requirements for the design, fabrication, inspection, tests and installation for various types of removable trays, packing and other internals for columns, reactors, separators, and similar.

2 Scope of validity

This specification applies to the preparation of tender documents, inquiries and contracts for newly planned investment or modernization projects of Grupa LOTOS S.A.

It shall also be a basis for preparing both detailed specifications and inquiries for individual or package unit supplies.

2.1 Deviations

Any deviation from this specification and the relevant specifications, standards and related documents including proposals, which the bidder claims to be economically and / or technically superior solutions must be submitted in writing for review and approval by Grupa LOTOS S.A. Non-approved exceptions are not acceptable by Grupa LOTOS S.A.

The supplier must report in writing any ambiguity in this or any other specifications of Grupa LOTOS S.A. or non-compliance with the referred documents / standards and obtain a written explanation from Grupa LOTOS S.A.

3 Design and Construction

3.1 General notes

Order of Precedence In case of conflicts existing between this specification and other documents, the following order of precedence shall govern:

- The current Polish legislation
- Terms of purchase order / contract and other requirements agreed in writing Grupa LOTOS S.A.
- Data Sheets approved by Grupa LOTOS S.A.
- This specification
- Other Specifications
- Drawings and other documents
- Standards

3.1.1 Reference Documents

Where reference is made to codes, specifications or standards, the reference shall be taken to the latest edition of the codes, specifications or standards, including addenda, and supplements thereto.

3.1.2 Regulations

In addition to the requirements of this specification, the design, fabrication and installation of internals shall be in accordance with all mandatory requirements of the applicable national, regional, local laws and regulations for the area of installation or as furnished by Grupa LOTOS S.A.

Tray assemblies shall be in compliance with Grupa LOTOS S.A. documents along with any other applicable specifications and/or standards referenced in the requisition or purchase documents unless modified herein. The use of Supplier standards not covered herein shall be subject to Grupa LOTOS S.A. approval.

3.2 Definitions

Internals shall be understood as trays, structural or random packing, mist eliminator (demisters), liquid distributors, grids, hold down grids, bed limiter and any other, including these welded to vessels.

Trays assembly or assemblies shall be all the component parts of trays such as, but not limited to: floors, weirs, downcomers, troughs, wells, baffles, rises, caps, beams, trusses, clamps, bolts, washers, gaskets, specialties of proprietary trays as well as support rings, downcomer bars, and other parts which are to be welded to the vessel.

3.3 Scope of Delivery and Services

3.3.1 Tray Manufacturer / Supplier

- Design complete tray assemblies.
- Design attachments such as support rings, support lugs and drip rings welded to column/vessel,
- Deliver complete tray assemblies incl. spare parts, except for support rings, downcomer bars and other parts, which are to be welded to the vessel.
- Deliver all seal pans and draw-offs unless specified otherwise
- Deliver required mill test reports.
- Prepare detailed drawings and instructions to facilitate shop or field installation.
- Perform trial assemblies for shop inspection and prepare inspection report. Provide mechanical, hydraulic and process performance guarantee.

3.3.2 Vessel Manufacturer

- Deliver and install (weld to vessel inside) all required support rings, downcomer bars and other parts which are to be welded to the column/vessel
- Inspect all installed parts and prepare inspection report.

3.3.3 Tray Installation Company

- Install all tray assemblies not welded to the vessel.
- Seal-weld all trays, seal pans, etc. specified to be liquid tight.

- Perform trial assembly prior to installation.
- Perform post installation inspection if required together with Grupa LOTOS S.A. inspection personnel and prepare inspection report. Close with gasket and bolt up vessel manholes.

3.4 Design

Trays shall be designed for the maximum and minimum loadings based on the data specified in the Data Sheet(s).

Multipass trays shall be designed for equal liquid/vapour ratios in each pass of the tray. Uncapped perforated areas are not acceptable.

3.4.1 Loading

Tray assemblies shall be designed for thickness without corrosion allowance for the following loading conditions to which the dead weight is to be added.

- The design load under operation conditions for tray assemblies at the structural design temperature shall be based on 50 mm of water on the active tray floor plus the downcomer(s) 50 % full of water, or a weight of water equal to the height of vapour risers above the tray floor, whichever is larger.
- The design load under upset conditions for tray assemblies at the structural design temperature shall be based on 150 mm of water on the active tray floor plus the downcomer(s) 67 % full of water, or a weight of water equal to the height of vapour risers above the tray floor, whichever is larger. Under upset conditions, the stress shall not exceed 67 % of the yield stress at operating temperature.
- For maintenance, all assemblies shall be designed for a concentrated load at any point without exceeding 67 % of the yield stress at ambient temperature for

Vessel diameter	Load
< 1800 mm	200 kg
< 3600 mm	300 kg
> 3600 mm	400 kg

3.4.2 Deflection

Deflection of assemblies under design load shall be limited to 1/900 of the column diameter, if process design reasons do not require less.

For large diameter vessels, an initial camber may be made in the principal support members of the assemblies so that they do not exceed the deflection due to dead load.

3.4.3 Stresses

The allowable stresses of all structural materials shall be as given in the design code:

ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

3.4.4 Corrosion Allowance

The corrosion allowance for all surfaces of removable parts of carbon steel assemblies shall be minimum ¼ and for parts welded to the vessel ½ of the corrosion allowance of the vessel.

No corrosion allowance is required for stainless steel and other high alloy assemblies.

3.4.5 Thickness

Minimum thickness for tray parts including corrosion allowance shall be:

Components	Carbon steel	High alloy and s.s.
Valves	---	1,5 mm
Bubble cups and risers	3,5 mm	1,5 mm
Other removable tray parts, e.g. floors, weir, downcomers, trusses, etc.	3,5 mm	2 mm
Support rings and downcomer bars	10 mm	6 mm
Parts welded to the vessel	10 mm	6 mm

The minimum diameter of bolting shall be not less than 3/8 "/ 10 mm.

Screw threads to be metric and in accordance with PN/DIN requirements

Gasketing tape shall have 1,5 mm min. thickness.

3.5 Materials

3.5.1 Trays and Supports

Materials used for tray support rings and other parts welded to the vessel shall be the same or equivalent as specified for the vessel inside.

Materials used for tray assemblies shall be as specified on the vessel drawings / data sheets.

All monel sheet and plate material shall be in the annealed and pickled and passivated condition.

All stainless steel sheet and plate material shall be in the pickled and passivated condition.

All parts of the tray assemblies not welded to the vessel shall be of the same material category.

Valves of carbon steel assemblies shall be made of 12 Cr materials.

Bolting for tray manways of carbon steel assemblies shall be 12 Cr materials.

Nuts shall be selected to minimize galling of threads.

3.5.2 Gasketing (when specified)

Gasketing shall be commercial quality fabricated from asbestos-free materials suitable for the process environment.

Gasketing tape may be used where possible.

Braided rope shall be used where gasketing tape is not suitable.

3.6 Construction Details

3.6.1 General Notes

Generally the design of removable trays and internals shall be such that all parts are removable through the vessel manhole, except one-piece cartridge type trays.

All like parts of tray assemblies shall be interchangeable. Symmetrical tray layouts shall be used where possible.

In small diameter flanged columns ranging from 300 to 1000 mm (12" to 40") cartridge trays are typically used. For easy installation there are joined together in bundles

All assemblies shall be designed to permit installation and removal from the top, unless otherwise specified in the Drawing/Data Sheet.Numbering of trays from bottom to top

All tray elements except support elements welded to the shell should be joined with bolts. Bolt spacing should assure tight joints.

The Manufacturer/Supplier shall assure the tightness of metal-to-metal connections without gaskets, except for bubble cap trays and distributors.

3.6.2 Tray Components

Each assembly, except one-piece cartridge type trays shall have a section(s) for use as an internal manway. These manways shall be removable from top and bottom. Internal manways shall be in a vertically line and of shape and size to permit easy access to every area of the tray.

Multi-pass trays shall be provided with internal manways on each pass of the tray.

All tray parts shall be designed for bolting or clamping. Clamping shall be used except where bolting is necessary for load supporting capabilities. Spacing of bolts or clamps shall be close enough to insure liquid-tight construction, and shall not exceed 150 mm. All joints and seams of trays specified to be liquid-tight shall be seal-welded on site.

All support members and stiffeners are to be located on the underside of the tray floor with the exception of open-type trusses supporting two trays. Stiffeners and support members in bubbling areas shall not exceed 75 mm in width and shall be designed so as not to impede or channel the liquid flow on the tray. The depth of stiffeners and support members shall not exceed 75 mm or 5 % of the column diameter whichever is greater. Depth of stiffeners and support members transverse to the liquid flow direction shall not exceed 20 % of the tray spacing.

A minimum of 20 mm overlap shall be provided between the tray floor section and support members.

Sumps, other than for draw-off purposes shall not be used.

Trays and seal pans not specified to be liquid-tight should be provided with drain holes.

Gasketing and packing shall only be used for installation of trays when specified. Fabrication shall provide tight metal-to-metal joints. Metal seal plates may be used to close construction joints where necessary.

3.6.3 Supports

Others shall design support rings, downcomer bars and all other parts welded to the vessel for welding to the vessel.

The Internals Manufacturer/Supplier shall furnish drawings and instructions for installation and fabrication of support rings, downcomer bars and all other parts welded to the vessel by the vessel Manufacturer or others. The drawing shall show clearly the type, size and extend of welding.

Width of tray support rings and downcomer support bars shall be as follows:

Vessel diameter (mm)		Width of ring (mm)	Width of downcomer bars (mm)
< 1200		40	100
≥ 1200	< 2400	50	110
≥ 2400	< 3600	60	120
≥ 3600	< 8000	70	120
≥ 6000	< 8000	80	130
≥ 8000		Individual design required	

Carbon steel rings shall be continuously strength welded on the top and stitch-welded with 50 mm welds on the underside. Distance between stitch welds shall not exceed 150 mm.

Carbon steel downcomer bars shall be continuously welded on both sides but may be welded to the shell from one side only with a full penetration weld if the other side is not accessible.

Alloy rings and bars shall be continuously welded on both sides. All brackets shall be continuously welded all around.

3.6.4 Technical documentation should contain:

- Detailed assembly drawings with a specification of parts and materials and the designation of the tallies of individual parts.
- A drawing of the vessel with support elements welded to the shell.
- Instructions for the assembly and levelling of trays with permissible tolerances.
- Permissible assembly tolerances

3.6.5 Workmanship

Holes for sieve trays shall be punched downward from the topsides of the trays.

Surfaces of fabricated parts shall be smooth and free from scale, dents and other defects. Burrs shall be completely removed from all perforated areas and edges of tray sections and tray manways.

All required welding should be done by metal-arc welding process.

3.6.6 Tolerances

Tray assemblies shall be designed to allow for maximum vessel out-of-roundness permitted by the Code.

The manufacturing and installation tolerances shown in relevant Grupa LOTOS S.A. Standard shall apply to trays for shop of field-fabricated vessels.

All tray parts (except parts welded to the vessel) affected by the toleranced dimensions shall be made adjustable so that when installed, the trays and pans will be within the specified tolerances.

3.7 Inspection of Assemblies

3.7.1 Shop Inspection

Prior to shipment, a trial assembly of each layout shall be made in the tray supplier's shop from parts selected at random, to ensure that parts are correct and that proper fit-up is obtained. The trial assembly shall be supported in a manner comparable to final installation. Grupa LOTOS S.A. or Grupa LOTOS S.A. authorized representative shall be notified and given an opportunity to check each assembly for completeness and compliance with specifications.

The internals Manufacturer/Supplier shall notify in writing (by e-mail and/or fax) Grupa LOTOS S.A. at least 10 working days in advance when the internals are be ready for inspection.

Inspection by Grupa LOTOS S.A. shall in no way relieve the internals Manufacturer/Supplier from the responsibility to meet the requirements of the purchase order documents.

3.7.2 Pre-installation

A complete assembly of one odd and one even numbered tray shall be carried out in accessible place on the ground if the Installation Company is not familiar with the type of trays. This assembly will reveal fit up problems, acquaint with parts and indicate missing parts or apparent problems that will occur during final assembly in vessel.

Notification shall be given to Grupa LOTOS S.A. at least 5 days prior to the b. m. assembly of first trays. Grupa LOTOS S.A. authorized representative shall be given opportunity to inspect trial assemblies.

All tray parts, particularly in pans, shall be inspected to ensure that they are free from excessive mill scale, grease, oil and foreign matter.

3.7.3 Post Installation

Recommended Inspection check-off list.

- Are tray parts free from mill scale, grease, oil and foreign matter, particularly in pans and behind downcomers?
- Are bolts and clamps properly tightened? Are required washers in place?
- Look for any improper material or size of bolts and washers!
- Do outlet weirs check for correct height!
- Do outlet weirs check for levelness!
- Check clearance between downcomers and respective tray below!
- Are there any excessive gaps or openings in trays not in compliance with the design?
- Check the ends of outlet weirs for excessive gaps!
- Are the downcomers properly tightened against the bolting bars?
- Have drain holes been provided to drain sections that can retain liquid upon shutdown?
- Confirm that all internal pipes are secured with clips!
- Check clearance between downcomer and inlet weir, if applicable!
- Is there excessive tray deflection from weight of Inspector?

- These checks shall be performed on each tray and a record of findings shall be kept.
- The inspection is not limited to before listed points if tray installation supervisor or Grupa LOTOS S.A. authorized inspector feels it necessary to check additional details.

3.7.4 Reports

A record of all findings during post installation inspection shall be prepared.

Manufacturer/Supplier shall deliver certified mill test reports which shall include all chemical and physical tests for all sheet, bar and bolting materials.

3.8 Preparation for Shipment

3.8.1 Marking

Each tray part shall be permanently piece-marked for identification in assembly by stencilling, stamping or indestructible tags with same markings as shown in drawings and packing list. Identical parts shall have the same marking.

All boxes shall be clearly marked in a manner, which identifies them with Grupa LOTOS S.A. order number, equipment number, and fabrication packing list.

3.8.2 Packing

All trays and tray parts shall be free from weld spatter or any other foreign matter.

Assemblies shall be coated with corrosion inhibitor oil before shipment. Any oil coating from manufacturing process may be left, unless specified otherwise.

Trays shall be packed to suit the particular mode of transportation so as to prevent damage during shipment.

All nuts, bolts, washers and other loose small parts shall be adequately packed in separate bags, boxes or cartons within the larger container if practicable and each of these packages shall have its own identification.

Tray parts for different vessels shall not be intermixed.

A copy of parts list and installation instructions shall be included in the shipment for each service.

Further information on packing and transport can be obtained from the packing and shipping instructions.

3.9 Spares

As construction spares the greater of the following quantities to compensate for possible loss shall be delivered.

- Bolts and nuts 5 % or 10 pieces of each size and material
- Washers 5 % or 10 pieces of each size and material
- Tray clamps 5 % or 10 pieces of each size and material
- Gaskets, packing 10 % or 3000 mm rope and tape.

3.10 Guarantees

3.10.1 Internals Manufacturer/Supplier

All materials, design and construction shall be subject to the conditions and guarantees required by the purchase order.

The internals Manufacturer/Supplier shall guarantee that the internals designed by him, will meet requirements specified in the purchase order. If internals do not fulfill requirements the internals Manufacturer/Supplier shall, without cost to Grupa LOTOS S.A., furnish new internals or redesign, and rebuild internals provided, so that the purchase order requirements will be met.

Drawings review, intermediate and final inspections of internals carried out by Grupa LOTOS S.A., and also Release Note do not relieve Manufacturer/Supplier from his responsibility to fulfill requirements of purchase order.

3.10.2 Internals Installation Company

The tray installation Company shall guarantee that the tray assemblies have been installed in accordance with drawings and instructions as specified in the purchase order documents and that all post installation inspection requirements of this specification have been fulfilled.

4 Relevant Documents

Any “Technical Specification” issued by Grupa LOTOS S.A. listed in Contract Files.

5 Codes and Standards

Codes and standards listed below form part of this specification. Each publication shall be the latest revision and addendum in effect at the Contract award, unless otherwise specified:

- ASME BPVC ASME Boiler & Pressure Vessels Code – Sections II, VIII, IX
- ASME B 1.1 Unified Inch Screw Threads (UN and UNR Thread Form)
- Obliged national, regional, local laws and regulation for the area of installation

6 Record of changes

No.	Date	Description	Introduced by
0		This specification entirely replaces the former LOTOS Group S.A. standard No. PR 07 223 with the same title.	B. Kowalewski
1	30-11-2013 (rev.1)	Review, update, standardize and changes to the Standard within scope of order No. OK/990/2012	Editorial board coordinated by T.Wróbel
-	31-08-2015	Page layout corrections, no contents changes.	T. Wróbel