PES-AD1-SH
Project Engineering Specification

Shipping Requirements for Heavy and Oversized Equipment

Rev.	Status	Description	Date	Prepared	Date	Checked	Date	Approved	AC
00		Shipping Requirements for Heavy and Oversized Equip.	08.11.18	Y. Celik	08.11.18	A. Große-Bley	8.11.18	R. Schuster	

Bar code

Category Code 1

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1 General

1.1 Scope

This specification covers additional requirements for transport of equipment and gives also requirements for shipping. It applies to all items of equipment defined as heavy and oversized equipment.

It is aimed to fulfil the shipping requirements for such equipment as per "IMO Code of Safe Practice for Cargo Stowage and Securing ".

1.2 Duplicate dimensions

Dimensions in tables shown in brackets are informative dimensions shown without brackets are binding.

1.3 Standards and Specifications

The latest edition or revision of the following documents are referenced and required as indicated herein or according to the technical specification:

a) The International Standard for Phytosanitary Measures (ISPM)
Revision of ISPM No.15 Regulation of wood packaging material (WPM) in international trade (2009).

b) The International Maritime Organization (IMO)
United Nations specialized agency with responsibility for the safety and security of shipping and the prevention of marine pollution by ships

c) IMO Code of Safe Practice for Cargo Stowage and Securing

d) WRC- Bulletin 297, Local Stresses in Cylindrical Shells Due to External Loadings on Nozzles – Supplement to WRC Bulletin No. 107; Mershon, Makhtarian, Ranjan, Rodabaugh, Welding Research Council Bulletin No. 297

e) Rickmers Standard for Stowage and Securing of Project Cargo- Edition 2014

1.4 Abbreviations

PES	=	Project Engineering Specification
TKUCE	=	thyssenkrupp Uhde Chlorine Engineers GmbH
F_T	=	Transverse force [N]
F_L	=	Longitudinal force [N]
V	=	Vertical force [N]
N_S	=	Number of transport saddles
m	=	Weight [kg]
N_L	=	Number of lashing points
g	=	Acceleration of gravity = 9.81m/s^2
d	=	Distance from centreline of clip to tipping axis [mm]
h	=	Distance from centre of gravity to base plate of saddle [mm]

L = Transport saddle width [mm]

FEA = Finite Element Analysis

1.5 Definition heavy and oversized equipment

Heavy and oversized equipment is defined as follows:

- exceeds 20 metric tons [22.026 short t] in weight and / or
- exceeds 12.00 m [472.441 in] in length and/or 2.40 m [94.488 in] in width and/or 2.40 m [94.488 in] in height.

1.6 Wood used for shipping and packing purposes

All wood used for wooden transport saddles, transport boxes, crates or protection of equipment surfaces or for any other purpose shall comply with the requirements of ISPM 15 to avoid problems in custom clearance of cargo.

2 Saddles and Supports

All equipment shall be provided with saddles or supports for transportation.

For sea transport rolling and pitching of the ships is to be taken into account. It should be considered that in heavy strong swell rolling angles of 30° or more may be experienced[1].

Therefore the saddle itself shall be designed to bear a vertical compression force

$$V = \frac{m}{N_S} \times 2 \times g$$

2.1 Saddles and Supports integrally connected

Integrally connected saddles and supports for horizontal equipment can be used for transport. The saddles must be designed to withstand the above written vertical compression force in addition to the design code requirements of the equipment.

2.2 Transport Saddles and Supports

Transport saddles and supports are provided for the sole purpose of transportation and temporary storage.

As transport saddles are not integrally connected to the equipment they shall be properly fixed to the equipment by proper lashing or bolted connections for transport.

Care shall be taken that no external attachments like clips for insulation, vacuum rings or other attachments will be damaged during installation.

Transport saddles and supports to be provided with an intermediate layer of non-skid rubber to avoid outer damage of the cargo and to increase friction.

The supplier of equipment is responsible for a proper calculation and fixing of transport saddles for the transportation. The preload forces for fixing the saddles to be given on transport drawing.

[1] Rickmers Standad for Stowage and Securing of Project Cargo- Edition 2014

Transport saddles shall be designed as follows:

- Minimum angle of saddle shall be 120°, refer to figure 2
- Width shall be equal to the vessel diameter

2.2.1 Wooden transport saddles

Wooden transport saddles may be provided for equipment < 30 metric tons [33.069 short t].

2.2.2 Steel transport saddles

Steel transport saddles shall be provided for vessels ≥30 metric tons [33.069 short t].

2.3 Footprint area for Saddles / Transportframes

In order to distribute the weight of the equipment on the ship's deck, the permissible footprint load of saddles shall < 200 kN/m^2 [29.006 PSI]. For illustration of the footprint area, see Figure 1 for ready reference.If this is not possible additional transport saddles shall be provided. Any deviation shall be reported to TKUCE prior to fabrication of the transport saddles for approval.

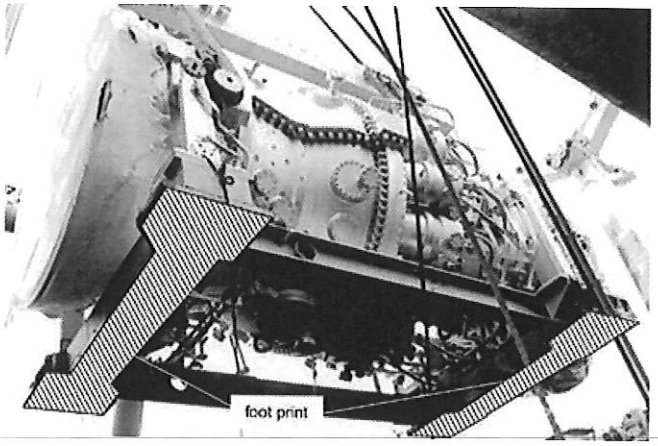

Figure 1: Example for footprint area of saddles

2.4 Saddles for Storage on Stools

For intermediate storage and handlings on trucks transport, equipment with a diameter of 6, m or more, two saddles must be strong enough to allow storage on stools, as shown in Figure 2. Saddles must be designed accordingly.

Any deviation shall be reported to TKUCE for approval.

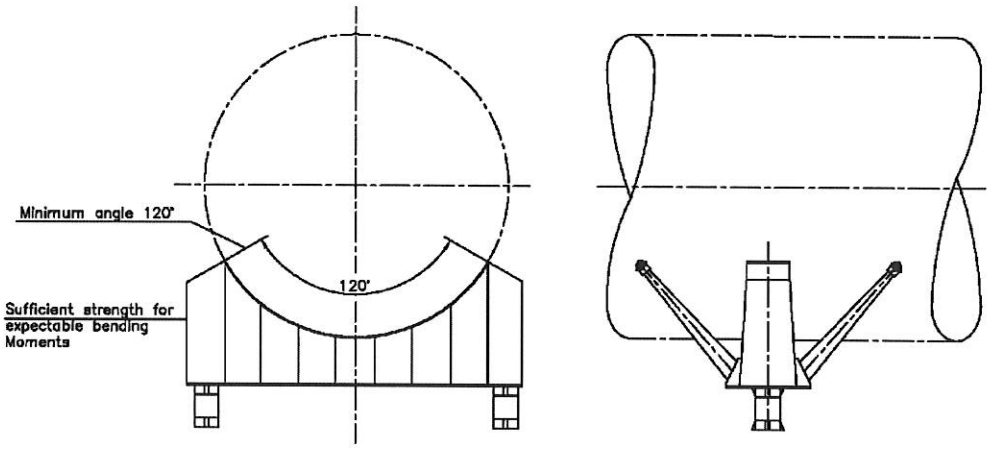

Figure 2: Saddle on stools

2.5 Saddles for Truck Transport with turntables

Equipment with more than 20 meter [787.402 in] length may be transported on trucks with turntables.

Therefore the two saddles for the transport with turntables, e.g. saddle 1 and 4 of Figure 3, shall be designed to bear the full weight of the equipment plus 20% safety margin. The vertical saddle force refer to chapter 2 must not be considered for these two saddles.

Saddles for land transport shall generally be secured against tipping in longitudinal direction acc. to Figure 2, right sketch.

Any deviation shall be reported to TKUCE for approval.

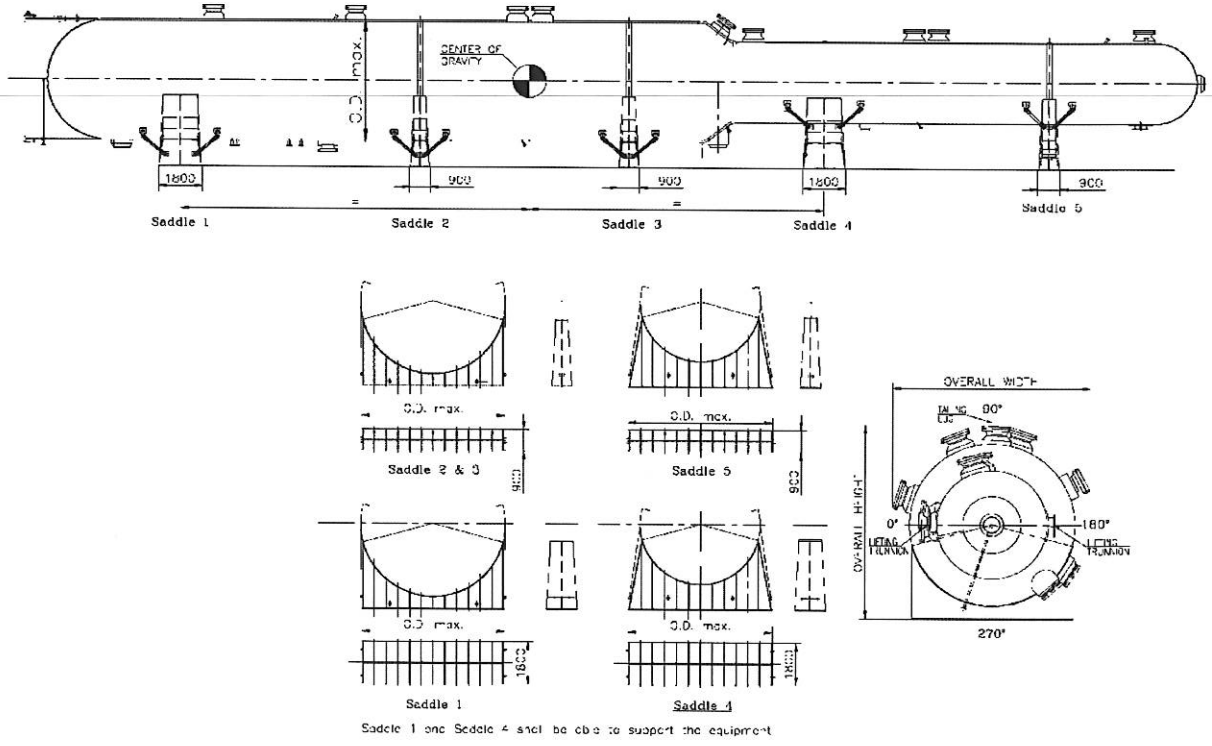

Figure 3: Example of multiple transport saddles.

3 Lifting points

For any lifting activity, lifting slings on the shell, lifting trunnions or lifting lugs shall be used. In any case the lifting arrangement shall be shown on the transport drawing including lifting forces (in kN and lb-f) at each lifting point and center of gravity.

The tailing lug shall be in the position required for erection (top of equipment) during transport.

4 Lashing points

Lashing points are locations on equipment, where it shall be fixed by steel-ropes or chains during transport. These lashing points may be lifting trunnions, lifting lugs, tailing lugs, skirts or lashing clips as per chapter 4.3.

All lashing points and clips shall be shown on the transportation drawing. For each clip the allowable load shall be given on drawing.

4.1 Design of lashing points

Lashing points shall be designed to meet the following requirements:

- Transverse sliding
- Longitudinal sliding
- Transverse tipping
- Longitudinal tipping (also consider trailer transport)

4.1.1 Transverse sliding

Lashing points shall be designed to bear a transverse force of

- $F_T = m \times g$.

4.1.2 Longitudinal sliding

Lashing points shall be designed to bear a longitudinal force of

- $F_L = m \times g$.

4.1.3 Transverse tipping

Lashing points shall meet the geometric requirement of $h \leq \frac{L}{2}$ to ensure that tipping will not occur.

If $h > \frac{L}{2}$

then the balance of force

$$\{m \times g \times h\} \leq \left\{ m \times g \times \frac{L}{2} + 0.9 \times \sum_{n=1}^{N_L} \left(Allowable\_Clip\_Load_n \times d \right) \right\}$$ with the allowable clip load from table 1 has to be considered. For illustration, see also

Figure 4.

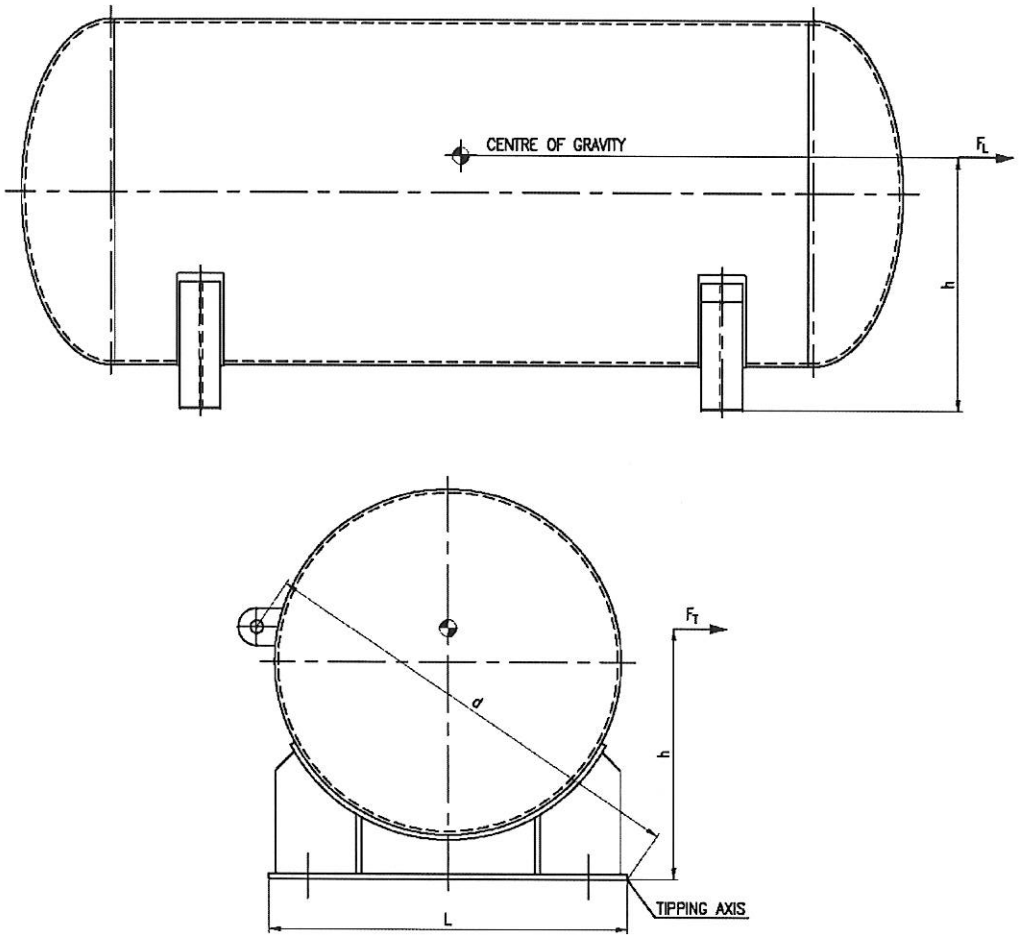

Figure 4: Transverse and longitudinal sliding forces

4.1.4 Number of lashing points

Sufficient number and size of lashing points shall be foreseen, the maximum allowable load per lashing point shall not exceed 500kN [112,404 lb-f].

The required number of lashing points can be calculated with

$$N_L \geq \frac{0.002 \times F_{L,T}}{Allowable\_Clip\_Load} \text{ ; with } N_L \geq 4.$$

The allowable clip load is given in table 1.

The equipment vendor is responsible to verify the allowed lashing point forces on the equipment shell.

In case a reinforcing plate is required between vessel wall and clip the plate thickness should be min. 0.7 x s1 (see table 1) and maximum vessel wall thickness. The verification of the vessel wall thickness respectively the reinforcement of the vessel wall shall be performed according to WRC Bulletin 107 or by means of FEA.

4.2 Use of existing points on equipment

Lifting trunnions and base rings of skirts for vertical equipment and tailing lugs may be used as lashing points. The maximum load for these points is to be given on the transportation drawing.

4.3 Lashing clips

Lashing clips according to this chapter fabricated from material with minimum yield strength of 205 N/mm², can be used without verifying the clip strength. The verification of the vessel wall thickness respectively the reinforcement of the vessel wall shall be performed according to WRC Bulletin 107 or by means of FEA. The lashing clips shall be painted in blue colour. The allowable clip load must be indicated next to the clip at the vessel wall.

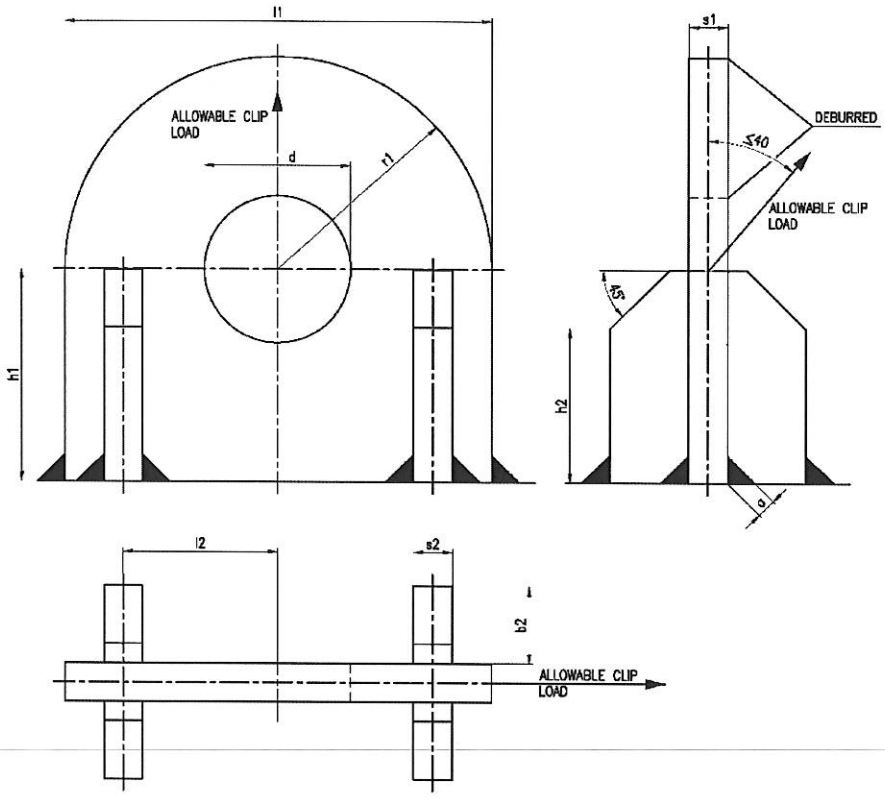

Figure 5: Lashing clips

No.	Allowable Clip Load [kN]	a min. [mm]	l1 [mm]	h1 [mm]	r1 [mm]	s1 [mm]	b2 [mm]	s2 [mm]	h2 [mm]	L2 [mm]	d [mm]
1	10	5	110	55	55	10	20	10	40	40	38
2	50	6	142	60	71	15	30	15	40	50	38
3	100	7	210	75	105	15	50	15	40	70	50
4	300	9	260	95	130	20	100	20	60	85	62
5	500	12	310	115	155	25	120	25	80	105	74

No.	Allowable Clip Load [lb-f]	a min. [in]	l1 [in]	h1 [in]	r1 [in]	s1 [in]	b2 [in]	s2 [in]	h2 [in]	L2 [in]	d [in]
1	2248	0.197	4.331	2.165	2.165	0.394	0.787	0.394	1.575	1.575	1.496
2	11240	0.236	5.591	2.362	2.795	0.591	1.181	0.591	1.575	1.969	1.496
3	22480	0.276	8.268	2.953	4.134	0.591	1.969	0.591	1.575	2.756	1.969
4	67422	0.354	10.236	3.740	5.118	0.787	3.937	0.787	2.362	3.346	2.441
5	112404	0.472	12.205	4.528	6.102	0.984	4.724	0.984	3.150	4.134	2.913

Table 1: Lashing clips for loads of 10 to 500 kN [2248 to 112404 lb-f]

4.4 Lashing point distribution

The lashing points should be distributed evenly and symmetrical to the centre of gravity.

4.5 Examples

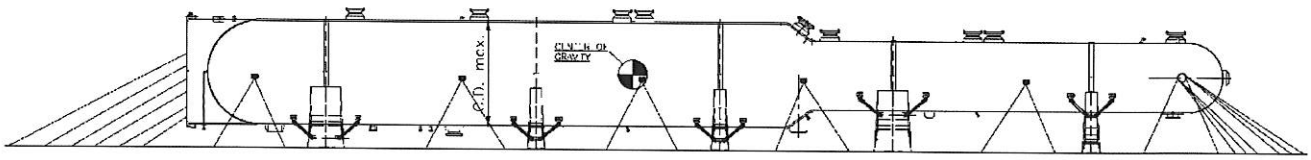

Figure 6: Example for transport saddle and lashing points

4.6 Structures / Modules / Box shaped equipment

Equipment structures like e.g. Convection Sections or Modules require special measures for lashing and securing due to their often high centre of gravity and weight. If lashing-clips as per 4.3 cannot be fixed on the equipment, forged D-Rings are to be installed.

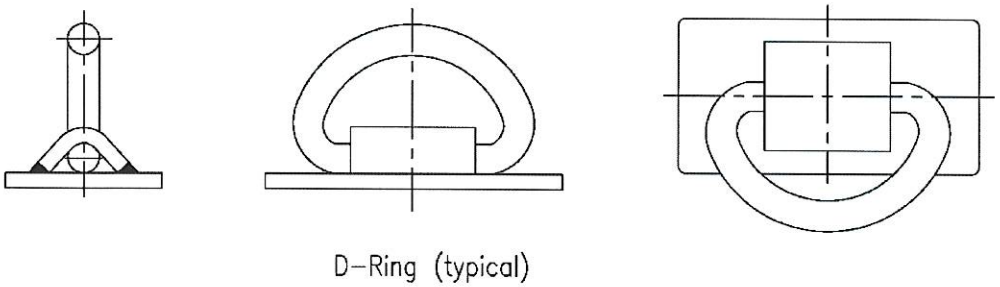

Figure 7: D-Ring

D-Rings are commercially available from e.g

- CARGOTEC (http://www.cargotec.com)
- SEC-BREMEN (http://www.sec-bremen.de)
- U.S. Cargo Control (http://www.uscargocontrol.com)
- Jiangxi Runyou Machinery Co.,ltd (http://www.jxrunyou.com)
- LG Supply (http://www.lg-rigging.com/)
- Others

The equipment manufacturer is responsible for fixing of D-rings to achieve the required securing loads as per 4.1 through 4.3

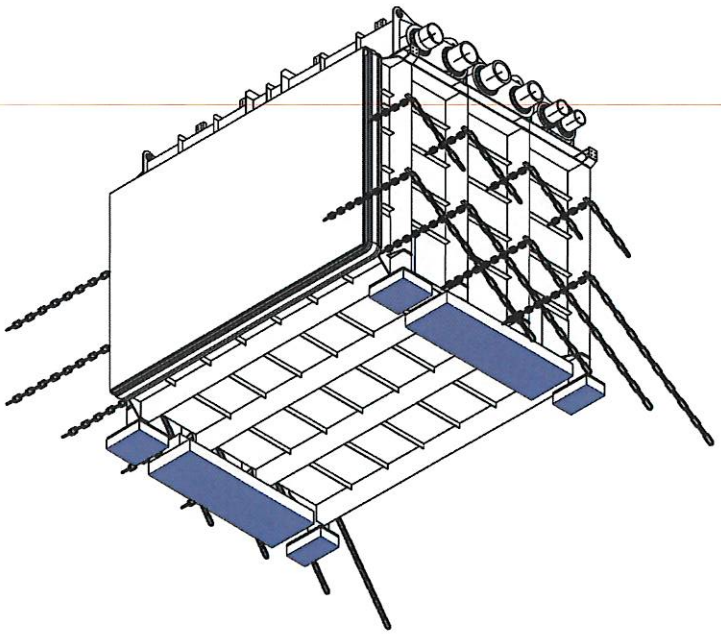

Figure 8: Example 1 for lashing of structures, modules or box shaped equipment

Lifting points shall be designed in such a way, that lifting of the item with a single lifting-beam is feasible, i.e. allows oblique tension force. If this is not feasible for technical reasons and a lifting frame must be used (see also paragraph 5), such frame should be directly bolted on to the lifting lugs and remain during the whole

transport and possibly erection phase. Such tailor made lifting frames and alike must be certified by a classification society (like Lloyds, DNV, Germanischer Lloyd). Such certificate must be available before transportation can begin. An eventual increase of overall cargo dimensions and weight has to be considered and indicated in the respective transport drawings and all respective documents.

In case of any doubt/question, supplier must check back with TKUCE, technical department for clarification.

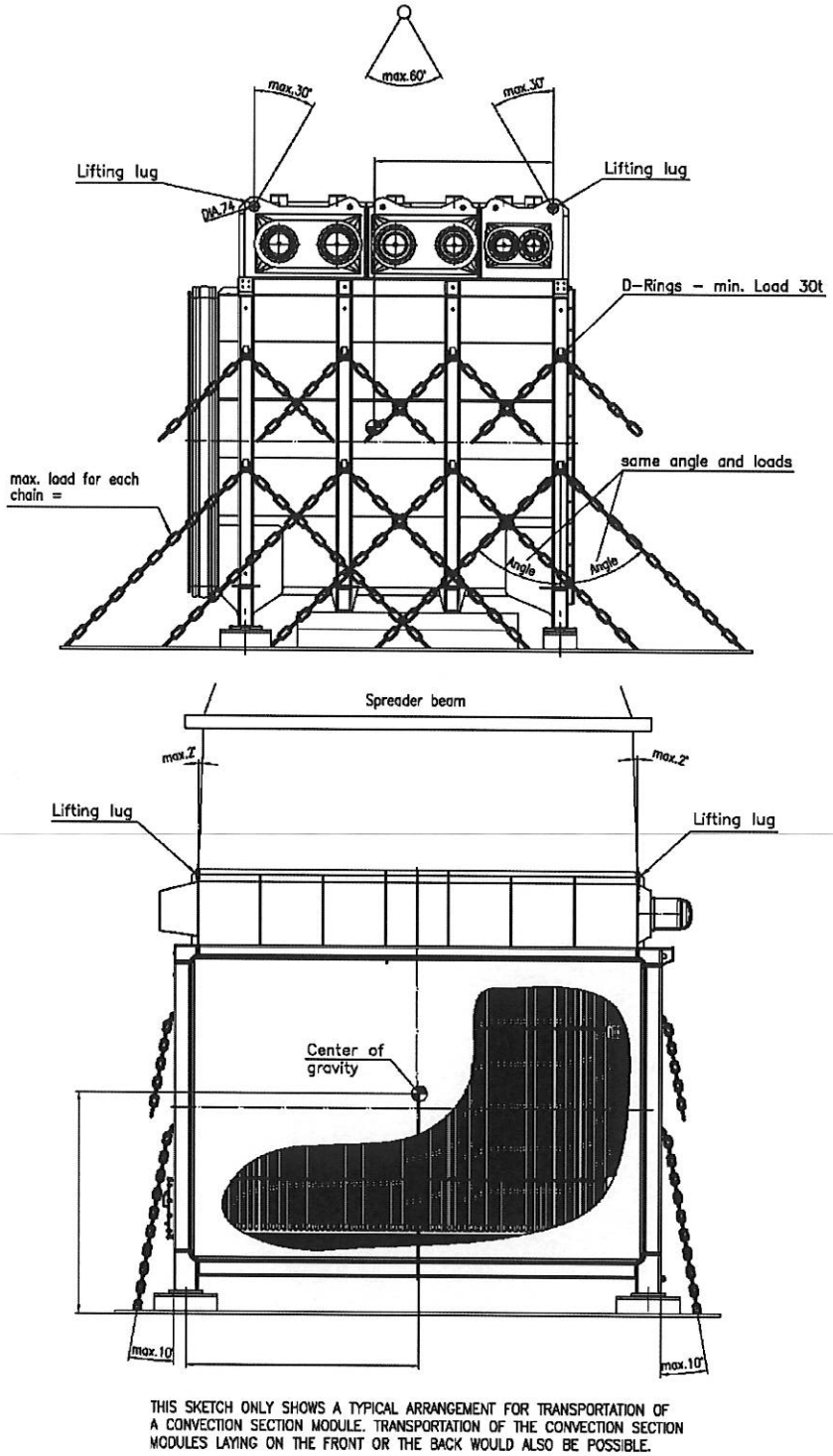

Figure 9: Example 2 for lashing of structures, modules or box shaped equipment

5 Non Standard Lifting Devices

Any special lifting device(s) required for equipment / packed units awaiting shipment (e. g. due to an offset centre of gravity or which requires non - standard tailor) shall be provided by the supplier. The scope of supply for the supplier is always up to hook unless otherwise specified. Any deviations have to be discussed with TKUCE engineering

The special lifting device shall be delivered with the official certificate covering cargo handling gear / test certificate which has been issued by a classification society (like Lloyds, DNV, Germanischer Lloyd etc.) before transportation can begin (see also packing instruction PES10MS-ST-01, item 4.1).

Dimensions and capacities of lifting beams, spreader bars and traverses shall be proposed by vendor and discussed with TKUCE for acceptance.

All lifting devices must be fully compatible with lifting points at the relevant piece of equipment.

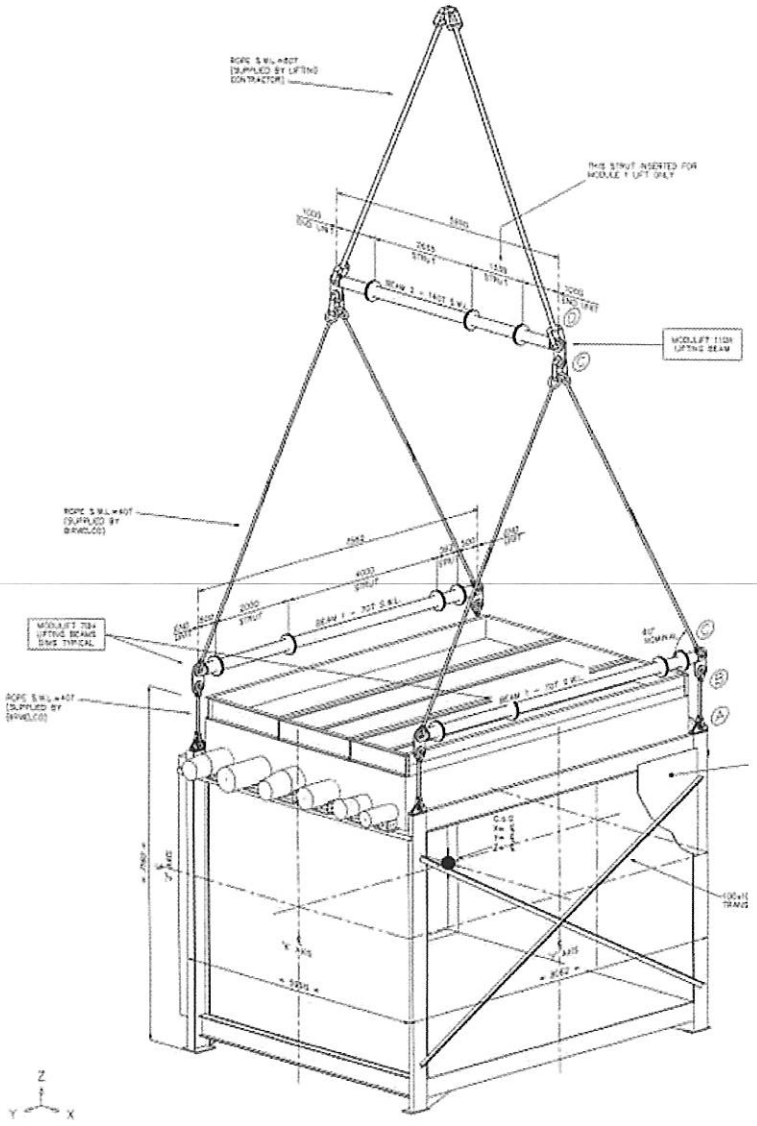

Figure 10: Example of Special lifting devices

6 Transport Drawing

A transport drawing shall be sent to TKUCE for approval, at least three months prior to Notification of Readiness for Dispatch. These transport drawings must clearly indicate the following information as a minimum:

a) Binding outer dimensions in the transport position, incl. any clips, accessories etc.
b) Top-, side- and front view with overall dimensions
c) Gross and net weight in kg
d) Centre of gravity (to be marked on each view and painted on equipment)
e) Transport saddles with location (reference must be clear), dimensions and loads per saddle
f) Slinging / lifting points with loads
g) Details of lifting-trunnions and -lugs
h) Lashing / securing points incl. allowable load
i) Type of envisaged packing (if any)
j) Special features to be considered (e.g. lifting by a traverse only) (if any)

Data such as dimensions and weights have to be marked in all views. Lifting points and lashing / securing points must be marked individually.

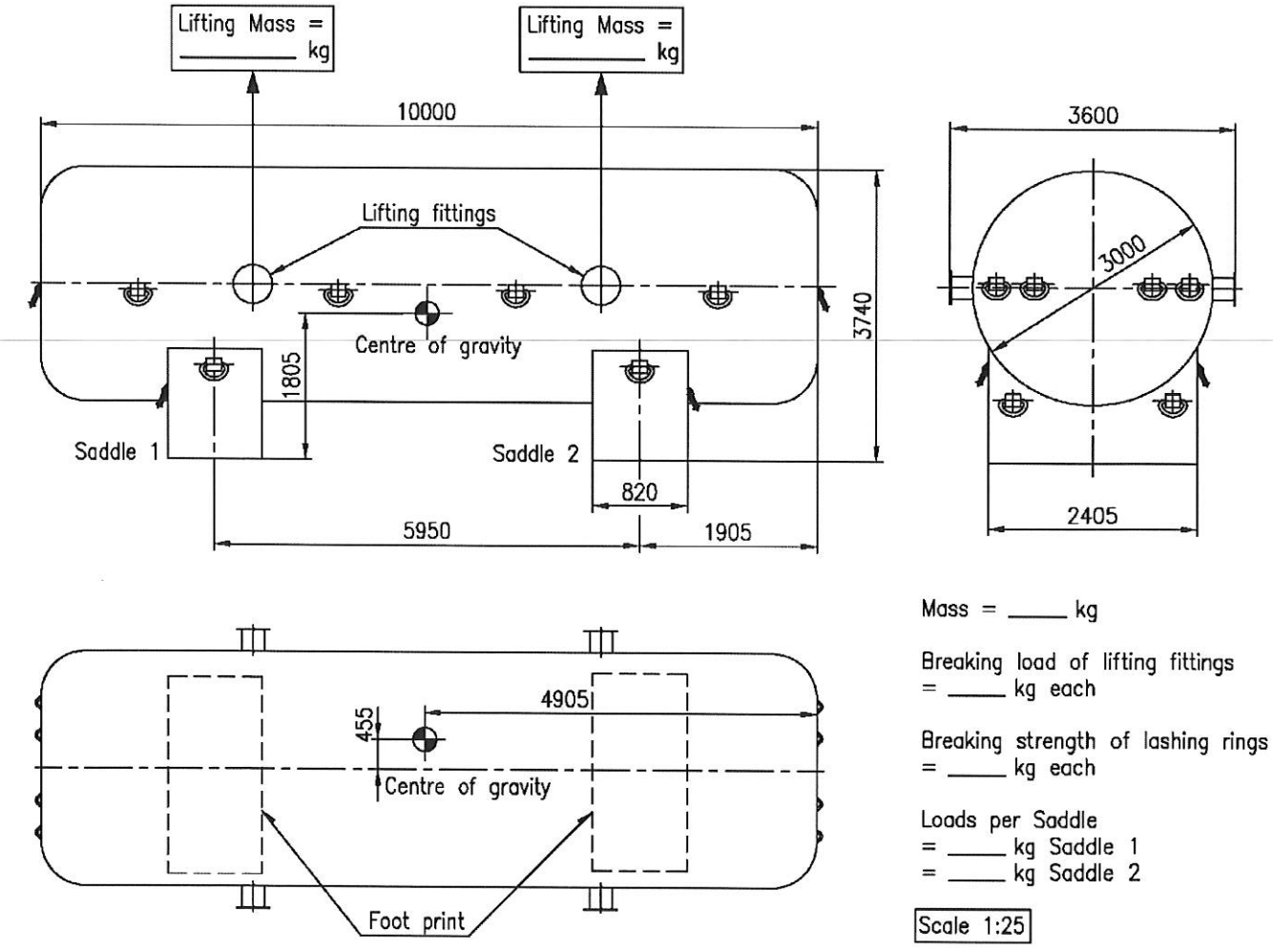

Figure 11: Sample Transport Drawing