Offshore Cargo Carrying Units

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Suggested revisions are invited and should be submitted to the Standards Department, API, 1220 L Street, NW, Washington, DC 20005, standards@api.org.

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Introduction

This API 2CCU standard applies to cargo carrying units (CCUs) specifically designed for repetitive use in the transport of goods and equipment to, from, or between fixed and/or floating offshore installations, ships, and/or shore-based operations. This standard outlines the criteria for the design, manufacturing, inspection, testing, and marking of CCUs, and takes into account the dynamic lifting and impact forces that can occur when handling such equipment in open seas.

Annex A outlines the assessment criteria and parameters of in-service CCU equipment for continued fit-for-purpose applications by users of CCU equipment in conjunction with equipment built to this standard.

Offshore Cargo Carrying Units

1 Scope

This standard defines the design, material, manufacture, inspection, repair, maintenance, and marking requirements for offshore cargo carrying units (CCU) and lifting sets, to include dry-goods boxes, baskets, and other skids designed to move equipment and goods offshore with maximum gross weight up to 70,000 kg (154,323 lb).

Annex A outlines the assessment criteria and parameters for in-service CCU equipment for continued fit-for-purpose applications by users of CCU equipment in conjunction with equipment built to this standard.

2 Normative References

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

API Recommended Practice 2D, *Operation and Maintenance of Offshore Cranes*

API Recommended Practice 2X, *Recommended Practice for Ultrasonic and Magnetic Examination of Offshore Structural Fabrication and Guidelines for Qualification of Technicians*

API Specification 9A, *Specification for Wire Rope*

API Specification Q1, *Specification for Quality Management System Requirements for Manufacturing Organizations for the Petroleum and Natural Gas Industry*

AISC[1] *Steel Construction Manual*

ASME[2] Boiler and Pressure Vessel Code (BPVC), Section IX, *Welding, Brazing, and Fusing Qualifications*

ASME B30.9, *Slings*

ASME B30.26, *Rigging Hardware*

ASNT[3]-TC-1A, *Personnel Qualification and Certification in Nondestructive Testing*

ASTM[4] A153/A153M, *Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware*

ASTM A193/A193M, *Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications*

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[1] The American Institute of Steel Construction, 130 East Randolph, Suite 2000, Chicago, IL, 60601, USA; www.aisc.org.

[2] The American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990, USA; www.asme.org.

[3] The American Society of Nondestructive Testing, 1711 Arlingate Lane, Columbus, OH 43228-0518, USA; www.asnt.org.

[4] ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959, USA; www.astm.org.

ASTM A194/A194M, *Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both*

ASTM A320/A320M, *Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service*

ASTM A370, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

ASTM A952/A952M, *Standard Specification for Forged Grade 80 and Grade 100 Steel Lifting Components and Welded Attachment Links*

ASTM E23, *Standard Test Methods for Notched Bar Impact Testing of Metallic Materials*

ASTM E112, *Standard Test Methods for Determining Average Grain Size*

ASTM E125/E125M, *Standard Reference Photographs for Magnetic Particle Indications on Ferrous Castings*

ASTM E165/E165M, *Standard Practice for Liquid Penetrant Examination for General Industry*

ASTM E213, *Standard Practice for Ultrasonic Testing of Metal Pipe and Tubing*

ASTM E433, *Standard Reference Photographs for Liquid Penetrant Inspection*

ASTM E709, *Standard Guide for Magnetic Particle Testing*

AWS D1.1, *Structural Welding Code — Steel*

AWS D1.2, *Structural Welding Code—Aluminum*

AWS D1.6, *Structural Welding Code — Stainless Steel*

EN[5] 818-6, *Short Link Chain for Lifting Purposes — Safety — Part 6: Chain Slings — Specification for Information for Use and Maintenance to be provided by the Manufacturer*

EN 1677-4, *Components for slings. Safety. Links, Grade 8*

EN 13411-1, *Terminations for steel wire ropes — Safety — Part 1: Thimbles for steel wire rope slings*

EN 13411-2, *Terminations for steel wire ropes — Safety — Part 2: Splicing of eyes for wire rope slings*

EN 13411-3, *Terminations for steel wire ropes — Safety — Part 3: Ferrules and ferrule-securing*

EN 13414-2, *Steel wire rope slings. Safety. Specification for information for use and maintenance to be provided by the manufacturer*

Federal Specification[6] RR-C-271, *Chains and Attachments, Carbon and Alloy Steel*

ISO[7] 3452-1, *Non-destructive testing — Penetrant testing — Part 1: General principles*

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[5] European Committee for Standardization, Avenue Marnix 17, 4th Floor, B - 1000 Brussels, Belgium; www.cencenelec.eu.

[6] Defense Logistics Agency Aviation VEB, 8000 Jefferson Davis Highway, Richmond, VA 23297-5616, www.dla.mil/Aviation.

[7] International Organization for Standardization, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland; www.iso.ch.

ISO 5817, *Welding — Fusion-welded joints in steel, nickel, titanium and their alloys (beam welding excluded) — Quality levels for imperfections*

ISO 7010, *Graphical symbols — Safety colours and safety signs — Registered safety signs*

ISO 9001, *Quality management systems — Requirements*

ISO 9606-1, *Qualification test of welders — Fusion welding — Part 1: Steels*

ISO 9606-2, *Qualification test of welders — Fusion welding — Part 2: Aluminium and aluminium alloys*

ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel*

ISO 10042, *Welding — Arc-welded joints in aluminium and its alloys — Quality levels for imperfections*

ISO 10675-1, *Non-destructive testing of welds — Acceptance levels for radiographic testing — Part 1: Steel, nickel, titanium and their alloys*

ISO 10675-2, *Non-destructive testing of welds — Acceptance levels for radiographic testing — Part 2: Aluminum and its alloys*

ISO 11666, *Non-destructive testing of welds — Ultrasonic testing — Acceptance levels*

ISO 15607, *Specification and qualification of welding procedures for metallic materials — General rules*

ISO 15609-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure specification —Part 1: Arc welding*

ISO 15614-1, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 1: Arc and gas welding of steels and arc welding of nickel and nickel alloys*

ISO 15614-2, *Specification and qualification of welding procedures for metallic materials — Welding procedure test — Part 2: Arc welding of aluminum and its alloys*

ISO 17636-1, *Non-destructive testing of welds — Radiographic testing — Part 1: X- and gamma-ray techniques with film*

ISO 17636-2, *Non-destructive testing of welds — Radiographic testing — Part 2: X- and gamma-ray techniques with digital detectors*

ISO 17637, *Non-destructive testing of welds — Visual testing of fusion-welded joints*

ISO 17638, *Non-destructive testing of welds — Magnetic particle testing*

ISO 17640, *Non-destructive testing of welds — Ultrasonic testing — Techniques, testing levels, and assessment*

ISO 23277, *Non-destructive testing of welds — Penetrant testing — Acceptance levels*

ISO 23278, *Non-destructive testing of welds — Magnetic particle testing — Acceptance levels*

WRTB[8] *Wire Rope Sling User's Manual*

[8] Wire Rope Technical Board, PO Box 151387, Alexandria, VA 22315-1387, www.wireropetechnicalboard.org.

3 Terms, Definitions, Abbreviations, and Symbols

For the purposes of this document, the following terms and definitions apply.

3.1 Terms and Definitions

3.1.1
cargo carrying unit
CCU
Structural unit designed for repeated use in the transport of goods and equipment to, from, or between fixed and or floating offshore installations, ships, and/or shore-based operations.

3.1.2
enhancement factor
A factor accounting for the offshore dynamic loads in the design.

3.1.3
essential non-redundant primary structure
Primary members that transfer the resulting cargo load to the crane hook or fork lift (e.g. forming the load path from the payload to the lifting sling); includes, at a minimum:

— top and bottom side rails;

— top and bottom end rails;

— corner posts;

— pad eyes; and

— forklift pockets.

NOTE Other primary structure may also be considered essential and/or non-redundant.

3.1.4
lifting set
A flexible, load-carrying member comprised of integrated lifting equipment between the hoisting device and the CCU structure.

3.1.5
lifting test
A test in which lifting equipment is subjected to a proof load as prescribed in the applicable section.

3.1.6
maximum gross weight
MGW
Rating or maximum gross weight of the CCU is the maximum design weight of the container and the cargo.

NOTE MGW = tare + payload

3.1.7
nonessential primary structure
Structural elements whose main functions are not essential and can be redundant.

EXAMPLE Floor plates and protective frame members. Side and roof panels, including corrugated panels, are not considered to be part of the primary structure.

3.1.8
payload <CCU>
working load limit
P
The maximum permissible mass or weight of cargo that is authorized for transport by the CCU.

3.1.9
permanent equipment
Equipment that is attached to the CCU that is not considered cargo.

3.1.10
primary structure
Load-carrying and supporting frames and load-carrying panels.

NOTE Primary structure includes, but is not limited to, the following structural components:

— load-carrying and supporting frames;

— load-carrying panels;

— forklift pockets;

— pad eyes;

— supports for heavy equipment;

— corner/knee brackets.

3.1.11
proof load test <lifting sets>
proof test
A test performed on a lifting set to a specific multiple of the rated load.

3.1.12
proof load test <CCU>
proof test
A test performed on a CCU in which the unit's pad eyes and primary structure is subjected to a specific load.

3.1.13
product specification level
PSL
Categories of design requirements based on the application.

3.1.14
qualified person
A person who, by possession of a recognized degree, certificate, or professional standing, or who, by knowledge, training, or experience, has successfully demonstrated the ability to solve or resolve problems relating to the subject matter or the work.

3.1.15
secondary structure
Components that are not considered "load carrying" for the purposes of the design calculations.

Secondary structures can include, but are not limited to, the following components:

— doors, wall, and roof panels;

— panel stiffeners and corrugations;

— internal securing points.

3.1.16
tare
T
The weight of the empty CCU, including any permanent equipment and excluding cargo and the lifting set.

3.1.17
tugger point
Attachments used for handling and not intended for lifting.

NOTE Tugger points are commonly used to move a CCU horizontally across the deck.

3.1.18
working load limit <lifting set>
WLL
Maximum mass or weight that a lifting component is designed to sustain in lifting service.

3.2 Abbreviations

COC certificate of conformance

EF enhancement factor

EIPS extra improved plow steel

HAZ heat-affected zone

IWRC independent wire rope steel core

MGW maximum gross weight

MTR material test report

PSL product specification level

RSL resulting sling load

WLL working load limit

3.3 Symbols

A shackle jaw width

C specified minimum yield strength

D_{H} diameter of pinhole

D_{pin} diameter of shackle pin

F shackle flange width

F_{h} horizontal impact force

F_{i} internal load

F_{L} design load on the primary structure

F_{p} pad eye total vertical load

F_{f} primary structure design load due to forklift operation

F_{v} maximum vertical impact force

F_{w} CCU wall internal load

g acceleration of gravity

h pad eye weld thickness

H_s significant wave height

l rail length

L pad eye length

LR load ratio

n number of pad eyes/lifting set legs

P payload

R_e specified minimum yield strength at room temperature

R_{pad} minimum radius of pad eye

$R_{p0.2}$ 0.2 % proof stress at room temperature

R_m specified minimum tensile strength at room temperature

S mass of lifting set

t thickness of pad eye at hole or material thickness

T tare weight of the empty CCU, including any permanent equipment and excluding cargo and the lifting set

T_M nominated minimum operating temperature

WLL working load limit

WLL_{min} minimum working load limit

y deflection of structural member

σ_e von Mises equivalent stress intensity

σ_c contact stress

σ_t tear-out stress

β angle between a sling leg and the vertical

4 Design

4.1 General

4.1.1 A CCU shall have sufficient strength to allow loading and unloading in open seas from a ship deck with a sea state up to a significant wave height, H_s, as follows:

— for PSL 1, lift from/to vessel in max H_s = 3 m (10 ft);

— for PSL 2, lift from/to vessel in max H_s = 6 m (20 ft).

4.1.2 The design and minimum operating temperature for CCUs designed and fabricated to this standard shall be in accordance with 5.2.

4.1.3 CCU designs shall be assessed and confirmed to meet the minimum requirements—to include engineered drawings with the AISC Steel Construction Manual or international design and analysis calculations—verified, and stamped by a licensed professional engineer, class society, or recognized regional authority.

4.2 Stability Against Tipping

4.2.1 To prevent CCUs from overturning (tipping) on a moving deck, they shall be designed to withstand the following minimum tilt angles in any direction without overturning as follows:

— for PSL 1, 15 degrees;

— for PSL 2, 30 degrees.

Cargo may be assumed to be evenly distributed, with center of gravity at one-half the height of the CCU.

4.2.2 For dedicated-purpose CCUs with a fixed center of gravity (e.g. bottle racks, service container, or tank container), the actual center of gravity shall be used.

4.3 Protruding Components

4.3.1 Protrusion on the outside of the CCU frame that can snag other structures should be avoided. Protrusions on the sides may be allowed if they will not result in snagging any other structure. Deflector plates may be used to mitigate potential snags.

4.3.2 Doors, handles, hatch cleats, etc., shall be placed or protected such that they do not snag the lifting set.

4.3.3 If supporting pads and fork pockets protrude below the bottom frame of the CCU, deflector plates shall be installed to prevent snagging. The CCU design should have provisions to minimize trapping of debris and to offset the potential of dropped objects.

4.3.4 Pad eyes may protrude above the top level of the CCU frame (see 4.7.6.1.1).

4.3.5 Stacking fittings, guides, and other structures that protrude above the top of the CCU frame shall be designed and located such that they will not catch on structures on the ship or on other deck cargoes during lifting operations. Stacking fittings should be designed such that they minimize the risk of damage to other CCUs or cargoes. They shall also be designed such that the damage to the stacking fittings does not cause damage to the pad eyes and lifting set.

4.4 Structural Design

4.4.1 CCUs shall be designed as structural frames (primary structure), with non-load-bearing cladding where necessary (secondary structure). Only the primary structure shall be considered in the design calculations.

4.4.2 For CCUs such as waste skips, tool boxes, etc., with quadrilateral shapes (with or without parallel sides) and with open-top or only a non-stressed cover above the bracing where the pad eyes are attached, the whole structure may be considered a primary structure, and the skip may be designed as a monocoque construction.

4.4.3 Connections between primary members shall be designed to provide continuity of the load path.

4.4.4 CCUs may be constructed such that part of the primary structure is removable.

4.4.5 Removable beams, walls, or covers shall be secured in such a way that they will not fall off, even if the securing device is damaged.

4.5 Structural Strength

4.5.1 General

The required strength of a CCU is determined by calculations and verified by testing, as described in Section 7.

4.5.2 Allowable Stresses

The von Mises equivalent stress shall not exceed the allowable stress and shall be limited to:

$$\sigma_e \leq 0.85 \times C \qquad (1)$$

where C:

— equals R_e (specified minimum yield strength) for steel, in kPa (lbf/in^2);

— equals $R_{p0.2}$, (0.2 % proof stress at room temperature), but not > 0.7 × R_m for aluminum (base material), in kPa (lbf/in^2);

NOTE $R_{p0.2}$ is the 0.2 % proof stress at room temperature and R_m is the specified minimum tensile strength at room temperature.

— equals the yield strength of the heat-affected zone (HAZ) for aluminum (weld and HAZ), in kPa (lbf/in^2).

NOTE In order to use the AISC Steel Construction Manual allowable stress limits on primary structure design, a higher design load is required; this is a very conservative approach. If the design does not meet the criteria specified in this section, the designer can still follow von Mises criteria to determine failure.

4.5.3 Load Distribution

The internal load is assumed to be evenly distributed. For CCUs with permanently mounted equipment, and for dedicated-purpose CCUs, the actual distribution of the internal load shall be used in the calculations.

4.5.4 Lifting Loads

4.5.4.1 Lifting with a Lifting Set

4.5.4.1.1 The design load on the primary structure shall be in accordance with Table 1.

Table 1—Primary Structure Design Load

Maximum Gross Weight *MGW*	PSL 1	PSL 2
≤ 25 tonnes (27.5 tons)	F_L = 2.5 × MGW	F_L = 2.5 × MGW
> 25 tonnes (27.5 tons)	F_L = 2.0 × MGW	
Key F_L is the design load on the primary structure, in lb (kg).		

4.5.4.1.2 The internal load (F_i), shall be calculated using the following equation:

$$F_i = (2.5 \times MGW - T) \qquad (2)$$

where:

MGW is the maximum gross weight, in kg (lb);

T is the tare weight of the empty CCU, including any permanent equipment and excluding cargo and the lifting set, in kg (lb).

4.5.4.1.3 The maximum deflection shall be evaluated and documented.

4.5.4.1.4 Pad eyes shall be designed for a total vertical load (F_p) of:

$$F_p = EF \times MGW \quad (3)$$

where:

EF is the enhancement factor.

The enhancement factor shall be selected from Table 2 or Table 3, based on the applicable PSL.

Table 2—Enhancement Factors for PSL 1 Equipment

Weight (*MGW*)		Enhancement Factors (*EF*)			
kg	lb	One pad eye	Two pad eyes	Three pad eyes	Four pad eyes
2000	4409	5.00	3.00	3.00	3.83
2500	5512	5.00	3.00	3.00	3.59
3000	6614	5.00	3.00	3.00	3.41
3500	7716	5.00	3.00	3.00	3.28
4000	8818	5.00	3.00	3.00	3.17
4500	9921	5.00	3.00	3.00	3.08
5000	11,023	5.00	3.00	3.00	3.00
5500	12,125	5.00	3.00	3.00	3.00
6000	13,228	5.00	3.00	3.00	3.00
6500	14,330	5.00	3.00	3.00	3.00
7000	15,432	5.00	3.00	3.00	3.00
7500	16,535	5.00	3.00	3.00	3.00
8000	17,637	5.00	3.00	3.00	3.00
9000	19,842	5.00	3.00	3.00	3.00
10,000	22,046	5.00	3.00	3.00	3.00
11,000	24,251	5.00	3.00	3.00	3.00
12,000	26,455	5.00	3.00	3.00	3.00
13,000	28,660	5.00	3.00	3.00	3.00
15,000	33,069	5.00	3.00	3.00	3.00
17,000	37,479	5.00	3.00	3.00	3.00
19,000	41,888	5.00	3.00	3.00	3.00
25,000	55,116	5.00	3.00	3.00	3.00
26,000	57,320	2.74	1.29	1.72	2.20
30,000	66,139	2.68	1.26	1.69	2.16
40,000	88,185	2.59	1.22	1.63	2.08
50,000	110,231	2.52	1.19	1.58	2.03
70,000	154,323	2.52	1.19	1.58	2.03

NOTE For intermediate *MGW* values, the enhancement factor may be interpolated.

Table 3—Enhancement Factors for PSL 2 Equipment

Weight (*MGW*)		Enhancement Factors (*EF*)			
kg	lb	One pad eye	Two pad eyes	Three pad eyes	Four pad eyes
2000	4409	7.56	3.56	4.75	6.08
2500	5512	6.97	3.29	4.38	5.60
3000	6614	6.53	3.08	4.11	5.25
3500	7716	6.19	3.00	3.89	4.98
4000	8818	5.92	3.00	3.72	4.76
4500	9921	5.69	3.00	3.58	4.58
5000	11,023	5.50	3.00	3.46	4.42
5500	12,125	5.34	3.00	3.35	4.29
6000	13,228	5.19	3.00	3.26	4.17
6500	14,330	5.07	3.00	3.18	4.07
7000	15,432	5.00	3.00	3.11	3.98
7500	16,535	5.00	3.00	3.05	3.90
8000	17,637	5.00	3.00	3.00	3.83
9000	19,842	5.00	3.00	3.00	3.70
10,000	22,046	5.00	3.00	3.00	3.59
11,000	24,251	5.00	3.00	3.00	3.49
12,000	26,455	5.00	3.00	3.00	3.41
13,000	28,660	5.00	3.00	3.00	3.34
15,000	33,069	5.00	3.00	3.00	3.22
17,000	37,479	5.00	3.00	3.00	3.12
19,000	41,888	5.00	3.00	3.00	3.03
25,000	55,116	5.00	3.00	3.00	3.00
26,000	57,320	3.51	1.66	2.21	2.82
30,000	66,139	3.41	1.61	2.14	2.74
40,000	88,185	3.21	1.51	2.02	2.58
50,000	110,231	3.08	1.45	1.94	2.48
70,000	154,323	3.08	1.45	1.94	2.48

NOTE For intermediate *MGW* values, the enhancement factor may be interpolated.

4.5.4.1.5 The load, F_p, shall be considered as being distributed between (n – 1) pad eyes where n is the actual number of pad eyes. For calculation purposes, n shall not exceed 4 or be less than 2.

4.5.4.1.6 To find the resulting sling load (RSL) on the pad eyes, the sling angle shall be taken into account. The RSL on each pad eye shall be calculated as:

$$RSL = \frac{(EF \times MGW \times LR)}{(n-1)\cos\beta} \tag{4}$$

where:

EF is the enhancement factor;

MGW is the maximum gross weight, in lb (kg);

β is the angle between a sling leg and the vertical;

LR is the load ratio of highest sling load to the average sling load;

n is the number of pad eyes.

Refer to Table 2 or Table 3 for EF values.

4.5.4.1.7 For asymmetrical sling loads, the load ratio (LR) is the ratio of highest sling load to the average sling load. If the sling loads are equal, LR = 1.

The design load for a single pad eye shall be determined by the following formula:

$$RSL = F_p = EF \times MGW \tag{5}$$

Refer to Table 2 or Table 3 for EF values.

4.5.4.1.8 CCUs that are built in sections that can be expanded or contracted in length as needs change may be used. As a result of this physical change, the CG and the angle of the lifting set can change.

4.5.4.2 Lifting with a Forklift

4.5.4.2.1 The mass of the lifting set, S, shall be taken into account when calculating the strength of the fork pockets. If S is not known, an estimated mass of the lifting set may be used in the calculations.

The design load on the primary structure, F_f, shall be calculated as:

$$F_f = 1.6 \times (MGW + S) \tag{6}$$

The internal load shall be determined by:

$$F_i = [1.6 \times (MGW + S) - T] \tag{7}$$

4.5.4.2.2 Where fork pockets are only intended for empty handling of the CCU, the design load shall be calculated as follows:

$$F_f = 1.6 \times (T + S) \tag{8}$$

For marking of the CCU with such pockets, see 10.1.

4.5.5 Impact Loads

4.5.5.1 General

Impact loads are dynamic loads of very short duration. Ideally, dynamic calculations or tests should be carried out. However, for most applications, it is sufficient to carry out simplified static calculations as outlined below to verify the local strength, and to perform a vertical impact test (see 7.1) to verify the CCU's overall ability to withstand such loads. Impact testing can be either physically performed on the CCU or a computerized, simulated vertical impact test.

4.5.5.2 Horizontal Impact

4.5.5.2.1 The main frame structure shall be designed to withstand a horizontal impact force (F_h) acting at any point. This force can act in any horizontal direction on the corner post. On all other frame members in the sides, the load may be considered as acting perpendicular to the side. Where relevant, the calculated stresses should be combined with lifting stresses. However, only stresses resulting from static lifting loads (MGW) need to be considered.

4.5.5.2.2 The following calculations shall be used for the static equivalents of impact load:

For weights less than 25 tonnes (27.5 tons), the horizontal impact force is calculated as follows:

$F_h = 0.25 \times MGW$, for corner posts and side rails of the bottom structure; (9)

$F_h = 0.15 \times MGW$, for other frame members of the side structure, including the top rails. (10)

For weights greater than 25 tonnes (27.5 tons):

PSL 1: $F_h = 0.05 \times 2.0 \times MGW$, for corner posts and side rails of the bottom structure; (11)

PSL 2: $F_h = 0.08 \times 2.5 \times MGW$, for corner posts and side rails of the bottom structure. (12)

For end or side structure and upper rails/edge, or reduced design load, equal to $F_{hr} = 0.6 \times F_h$ applies.

Calculated equivalent stresses shall not exceed:

$$\sigma_e = 0.85 \times C \tag{13}$$

where:

$C = R_e$, in kPa (lbf/in^2) (see 4.5.2).

The maximum calculated deflections with these loads shall not exceed:

$$y = \frac{l}{250} \tag{14}$$

where:

l is the total length of the rail or post (for corner posts and bottom side rails) in mm (in.); or

l is the length of the shortest edge of the wall being considered (for other frame members) in mm (in.).

4.5.5.3 Vertical Impact

4.5.5.3.1 Maximum vertical impact forces, F_v, are likely to occur when a CCU is lowered down to a heaving ship deck. If the deck is at an angle, the first impact will be on a corner. Such impact forces cannot readily be simulated by static forces. As dynamic calculations can be very complex, it is usually sufficient to verify the strength by a vertical impact test as described in 7.1, or to perform a computerized simulated vertical impact test.

4.5.5.3.2 The side rails and end rails in the bottom shall be able to withstand vertical point impact forces at the center of the span.

For weights less than or equal to 25 tonnes (27.5 tons), the vertical impact force is calculated as follows:

$$F_v = 0.25 \times MGW \tag{15}$$

For weights greater than 25 tonnes (27.5 tons):

$$F_v = 0.2 \times MGW \tag{16}$$

Calculated equivalent stresses shall not exceed:

$$\sigma_e = 0.85 \times C \tag{17}$$

where:

C is the specified minimum yield strength, R_e , in kPa (lbf/in^2) (see 4.5.2).

The maximum calculated deflections with these loads shall not exceed:

$$y = \frac{l}{250} \tag{18}$$

where:

l is the total length of the rail, in mm (in.).

4.5.6 CCU Walls

Each CCU wall, including the doors, shall be designed to withstand (without exceeding the yield strength) an internal load, F_w, evenly distributed over the whole surface of the wall or door, to be calculated as follows:

$$F_w = 0.6 \times P \times g \tag{19}$$

where:

P is the payload, in kg (lb);

g is the standard acceleration of gravity.

4.6 Welding

Welds on pad eyes and the essential nonredundant primary structure shall be full penetration welds.

For all other welds, the weld strength shall be based on the nominal weld area and the stress intensity produced by the design load. The allowable stress for the weld shall be as designated in 4.5.2, multiplied by the following reduction factors:

— 0.5 for fillet welds;

— 0.75 for partial penetration welds, and fillet welds where the throat area of the fillet weld is equal to or less than the stress area of the partial penetration weld;

— 1.0 for full penetration welds.

4.7 Additional Design Details

4.7.1 Floors

A CCU that can become filled with water shall have drainage capability.

4.7.2 Doors and Hatches

Doors and hatches with hinges and locking devices shall be designed to withstand the same horizontal forces as the primary structure. Locking devices shall prevent doors and hatches from opening during transport and lifting. Double doors shall have at least one locking device on each door.

Locking mechanisms shall be protected to prevent dislodgement by impact. Hinges shall be protected against damages from impact loads. Doors shall have a secondary means of locking.

4.7.3 Internal Securing Points

CCU for general cargoes should have internal securing points. Each internal lashing point shall be designed for lashing forces of at least 10 kN (2250 lbf).

4.7.4 Forklift Pockets

4.7.4.1 The CCU should be fitted with one or more sets of forklift pockets in the bottom structure.

4.7.4.2 If equipped with forklift pockets, the minimum opening should be 7.9 in. wide × 3.5 in. high (200 mm wide × 90 mm high).

4.7.4.3 If present on the CCU, the forklift pockets shall be located such that the CCU is stable during handling with the forklift. CCU length, height, width, and rating shall be taken into account. Forklift pockets shall be located as far apart as practical. See Table 4 for recommended forklift pocket distances and operational limitations.

Table 4—Recommended Forklift Pocket Distances and Operational Limitations

CCU Length L	Minimum Distance Between Centers of Pockets	Limitations
L < 6000 mm (236 in.)	According to 4.7.4.3	If 3000 mm ≤ L < 6000 mm (118 in.≤ L < 236 in.), the pockets for loaded handling should be spaced at least 1500 mm (59 in.) apart.
6000 mm ≤ L ≤ 12,000 mm (236 in. ≤ L ≤ 472 in.)	2050 mm (81 in.)	Pockets for loaded handling
	900 mm (35 in.)	Pockets for empty handling
12,000 mm < L ≤ 18,000 mm (472 in. < L ≤ 709 in.)	2050 mm (81 in.)	Empty handling only
L > 18,000 mm (709 in.)	—	No pockets

4.7.4.4 Forklift pockets shall have closed tops and sides. The bottom face of forklift pockets may be fully closed or have partial openings. Openings in bottom plates shall have such size and location as to minimize the risk that:

— the fork tines may penetrate or seize in the opening; or

— they damage the free edges at the cut-out.

If there are openings in the bottom of fork pockets, the openings shall not be within 200 mm (7.9 in.) from the sides of any intersecting members.

4.7.4.5 If a CCU is fitted with pockets that are only for empty handling, the CCU shall be marked appropriately.

4.7.4.6 The shear area in the bottom side rail shall be sufficient, taking into account the reduction of the vertical shear area in the way of the forklift pockets. If additional strengthening is placed on top of the side girder, this shall be in line with the web(s) of the bottom girder, extend at least 100 mm (3.9 in.) outside the pocket opening at each end, and be welded with full penetration welds.

4.7.5 Top Protection

4.7.5.1 Top protection may be necessary depending on the application.

4.7.5.2 Where equipped, top protection may be fixed, hinged, or removable, and shall be capable of being securely fitted to the CCU. Top protection may be either rigid or flexible, and may be made from plates, grating, GRP, tarpaulin, nets/mesh, webbing, etc.

4.7.5.3 Rigid top protection shall be designed to withstand a load of 3 kN (675 lbf) uniformly distributed over an area of 600 mm × 300 mm (23.6 in. × 11.8 in.), located anywhere on the top protection.

4.7.5.4 Flexible top protection shall be capable of supporting a central load equal to $0.03 \times MGW$. However, the design load shall not be less than 1 kN (225 lbf) and need not be more than 3 kN (675 lbf). The strength of the top protection shall be documented. CCUs with flexible top protection shall be marked in accordance with 10.1 d).

4.7.5.5 Fixtures for the top protection shall be such that they do not cause a snagging hazard.

4.7.5.6 The top protection should cover the entire roof of the CCU. Small openings may be incorporated, e.g. to permit the passage of slings when pad eyes are located below the top protection.

4.7.5.7 In the case of long baskets where top protection is required, and where the pad eyes are not located at the ends of the baskets, top protection need not extend over the whole length of the basket, but shall at least extend between the pad eyes and 1 m (3.3 ft) beyond the pad eyes, such that the lifting set (including forerunner) cannot enter the basket.

4.7.6 Pad Eyes

4.7.6.1 Pad Eye and Shackle Dimensions

4.7.6.1.1 Pad eyes shall not protrude outside the side boundaries of the CCU, except as necessary to weld the back edge of the pad eye plate to the outside surface of the corner post. The pad eye may protrude above the top of the CCU, subject to the conditions stated in 4.3.

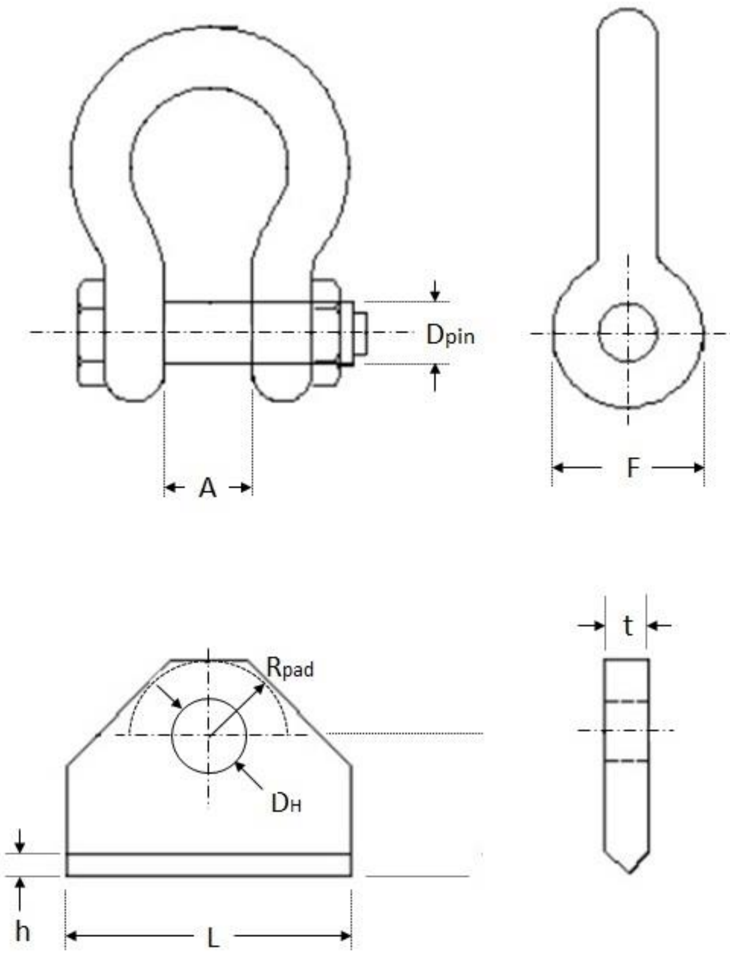
4.7.6.1.2 To prevent lateral bending moments, pad eyes should be aligned with the sling to the center of lift, with a maximum manufacturing tolerance of ± 2.5°.

4.7.6.1.3 Swivel hoist rings designed and manufactured for offshore application may be used in place of pad eyes to eliminate misalignment.

4.7.6.1.4 For symmetrical lifting sets, the difference in the measurements between the centers of diagonal lifting points shall not exceed 0.2 % of the nominal length of the diagonal, or 5 mm (0.2 in.), whichever is greater.

4.7.6.1.5 Shackles shall be selected before designing the lifting pad eye.

4.7.6.1.6 The pad eye hole diameter shall be selected to fit the shackle pin diameter. For strength purposes, the difference in hole and pin diameter should be as small as practical, but shackle pin maximum diameter including tolerance shall be considered in order to verify that the pin will enter the hole. See Figure 1 for pad eye and shackle dimensions.



Key

D_{pin}	diameter of shackle pin	h	pad eye weld thickness
D_H	diameter of pinhole	A	shackle jaw width
t	thickness of pad eye at hole	F	shackle flange width
R_{pad}	minimum radius of pad eye	L	pad eye length

Figure 1—Pad Eye and Shackle Dimensions

4.7.6.1.7 The pad eye hole diameter should not be greater than 1.15 times the shackle pin diameter for shackles with a pin diameter > 38.1 mm (1.5 in.). For shackles with a pin diameter < 38.1 mm (1.5 in.), the pad eye hole diameter should not be greater than 1.20 times the shackle pin diameter.

4.7.6.1.8 Pad eye maximum concentrated hot-spot stresses at the hole edges shall not exceed 2 × R_e at design load.

4.7.6.1.9 The thickness of the pad eye at the hole, including cheek plates or bushing, should be between 75 % and 90 % of the inside width of the joining shackle.

4.7.6.1.10 If the lifting force is transferred through the thickness of the plate (the z-direction), plates with specified through-thickness properties shall be used.

4.7.6.1.11 The pad eye design shall allow free movement of the shackle and sling termination without fouling the lifting set eye.

4.7.6.1.12 The radius of the pad eyes (R_{pad}) should be 1.75 to 2 times the pad eye pin hole diameter (D_H). For pad eyes with R greater than two times the pin diameter, the clearance of the wire rope with thimble inside the shackle eye should be evaluated for adequate clearance.

4.7.6.1.13 The minimum distance from the base of the pad eye to the centerline of the pad eye pin hole, H, shall be designed such that the shackle jaw does not interfere with the weld.

The recommended clearance may be calculated as follows:

— clearance = 12.7 mm (0.5 in) for shackles with $F_p \leq$ 57,827 N (13,000 lbf);

— clearance = 25.4 mm (1.0 in) for shackles with $F_p >$ 57,827 N (13,000 lbf).

For $F_p \leq$ 57,827 N (13,000 lbf):

$$H = \left(\frac{F}{2} + h\right) + 12.7\text{ mm}\text{, in SI units;} \tag{20}$$

$$H = \left(\frac{F}{2} + h\right) + 0.5\text{ in.}\text{, in U.S. Customary units;}$$

where:

F is the shackle flange width in mm (in.);

h is the pad eye weld thickness, in mm (in.).

For F_p > 57,827 N (13,000 lbf):

$$H = \left(\frac{F}{2} + h\right) + 25.4\text{ mm}\text{, in SI units;} \tag{21}$$

$$H = \left(\frac{F}{2} + h\right) + 1.0\text{ in.}\text{, in U.S. Customary units;}$$

The calculation for lift subs machined from bar stock for F_p > 57,827 N (13,000 lbf) is:

$$H = \left(\frac{F}{2} + h\right) + 12.7\text{ mm}\text{, in SI units;} \tag{22}$$

$H = \left(\frac{F}{2} + h\right) + 0.5\text{ in.}$, in U.S. Customary units.

4.7.6.2 Stress Calculations

4.7.6.2.1 Contact Stress

For $D_{\text{pin}} \geq 0.94 \times D_{\text{H}}$, the contact stress, σ_{c} is calculated as follows.

$$\sigma_{\text{c}} = 0.045\sqrt{\frac{RSL \times E}{D_{\text{H}} \times t}} \tag{23}$$

where

RSL is the resulting sling load on the pad eyes;

E is the elastic modulus of the material, in MPa (ksi);

D_{H} is the pad eye hole diameter, in mm (in.);

t is the thickness of pad eye at hole/material thickness, in mm (in.).

For $D_{\text{pin}} < 0.94 \times D_{\text{H}}$, the contact stress, σ_{c} , is calculated as follows.

$$\sigma_{\text{c}} = 0.18 \times \sqrt{\frac{RSL \times \left(\frac{1}{D_{\text{pin}}} - \frac{1}{D_{\text{H}}}\right) \times E}{t}} \tag{24}$$

4.7.6.2.2 Tear-out Stress

The equation for tear-out stress is:

$$\sigma_{\text{t}} = \frac{2 \times RSL}{\left(2 \times R_{\text{pad}} - D_{\text{H}}\right) \times t} \tag{25}$$

The equivalent von Mises stress at any critical point, including the weld, shall be within the allowable stresses (see 4.5.2).

4.7.6.3 Out-of-plane Loads

Out-of-plane loads on pad eyes are due to

a) the design angle between sling and pad eye plate planes;

b) inaccuracies in pad eye fabrication and lifting set design considered (e.g. due to hook size) causing an angle between sling and pad eye plate planes; or

c) any specified angle differences between the crane hoist line and the line from the hook center to the CCU center of gravity, which can be due to:

— inclined transport vessel deck during lift-off;

— a hoist line is out-of-plumb during lift-off; or

— horizontal loads on CCUs from tugger lines and impacts.

The condition described in item a) should be avoided. If not avoided, out-of-plane loading due to this condition can be calculated to determine acceptable load levels for all CCU designs. In order to take into account item b), a 5 % out-of-plane loading shall be applied in the shackle bow. The required lift-off vessel angle can be considered in order to take into account item c).

Out-of-plane load effects due to horizontal loads can be disregarded for three- and four-leg lifting sets if none of the slings became slack due to the considered angle.

4.7.7 ISO Corner Fittings

CCUs shall not be designed to be lifted offshore with shackles or hooks in corner fittings designed to ISO 1161.

4.7.8 Permanent Equipment

Permanent equipment installed in a CCU is considered to be part of the CCU. The CCU shall be designed to withstand the dynamic loading and other environmental forces.

4.7.9 Coating and Corrosion Protection

CCUs shall be suitable for the offshore environment by means of construction, use of suitable material, and/or corrosion and paint protection.

4.7.10 Tugger Points

If tugger points (attachments used for handling without lifting) are fitted, they shall be:

a) designed for a load equal to the CCU rating, *MGW*;

b) attached to the primary structure;

c) placed as far down on the structure as practical; and

d) placed within the outer edges of the CCU.

5 Materials for CCU Structures

5.1 General

The chemical composition, mechanical properties, heat treatment, and weldability shall be fit for the intended purpose. Steels shall comply with the material requirements of the recognized standard and applicable additional requirements specified below. Steels in primary structure shall be fully killed. Materials that are naturally age hardened shall not be used. Steels with specified minimum yield strength above 500 MPa (72.5 ksi) shall not be used.

NOTE The term “killed” indicates that the steel has been completely deoxidized by the addition of an agent such as silicon or aluminum before casting, so that there is practically no evolution of gas during solidification. Killed steels are characterized by a high degree of chemical homogeneity and freedom from porosity.

Welding consumables shall be according to recognized standards, such as AWS or ASME.

5.2 Design Temperature

The design temperature shall not be greater than the lowest operating temperature for the CCU. In the absence of a design temperature designation, the design temperature shall be –20 °C (–4 °F).

CAUTION The equipment should not be used at the full load rating at temperatures below –20 °C (–4°F) unless appropriate materials with the required toughness properties at lower design temperature have been used.

5.3 Minimum Material Thickness

The minimum material thicknesses in Table 5 shall apply, along with the following:

a) Applicable thicknesses for monocoque-type CCUs should be evaluated on a case-by-case basis;

b) Secondary structure made of metal: t = 2 mm (0.078 in).

Table 5—Minimum Material Thickness for Steel Sheet

Maximum Gross Weight tonnes (tons)	**Corners** mm (in.)	**Other** mm (in.)
0 to 1 (0 to 1.10)	4 (0.164)	4 (0.164)
1 to 25 (1.10 to 27.56)	6 (0.239)	4 (0.164)
≥ 25 (27.56)	8 (0.312)	6 (0.239)

5.4 Wrought Steel

5.4.1 Steel shall comply with the material requirements of a recognized code. The chemical composition, mechanical properties, heat treatment, and weldability shall be satisfactory for the service, as well as for the fabrication process.

5.4.2 Primary structural members should be manufactured in accordance with API 2H, ASTM A572, ASTM A516, or other recognized industry standards with impact-testing or fine-grain provisions.

5.4.3 Steel shall have a maximum hardness of 35 HRC. This is the conservative hardness to avoid hydrogen embrittlement for lifting or fastener applications.

5.4.4 Grain size shall be ASTM E112, Size 5 or finer.

5.4.5 Forgings shall have a minimum 3:1 forging reduction ratio. Rolled steel shall have a minimum reduction of 5.0.

5.4.6 Steel shall possess adequate fracture resistance energy to avoid the initiation of brittle fracture. Steels for primary structure shall be Charpy (V-notch) impact tested in accordance with ASTM A370, ASTM E23, or an equivalent international standard for each mill run. Charpy testing is not required for minimum operating air temperatures of 0 °C (32 °F) or higher. The use of a sub-size specimen is permitted when the amount of material available does not allow for standard impact test specimens. Smaller specimens may be used, but the results obtained on different sizes of specimens cannot be compared directly. Austenitic stainless steels are exempt from the impact-testing requirement.

5.4.7 Impact energy requirements depend on the specified minimum yield strength of the material, as shown in Figure 2.

5.4.8 Impact test temperatures shall be equal to or less than the temperatures given in Table 6.

5.4.9 The required minimum average Charpy values shall be determined from Figure 2 using the minimum yield strength of the material.

EXAMPLE A 359 MPa (52 ksi) minimum specified yield material will require a minimum average Charpy value of 34 J (26.5 ft-lb). The test temperature is defined in Table 6.

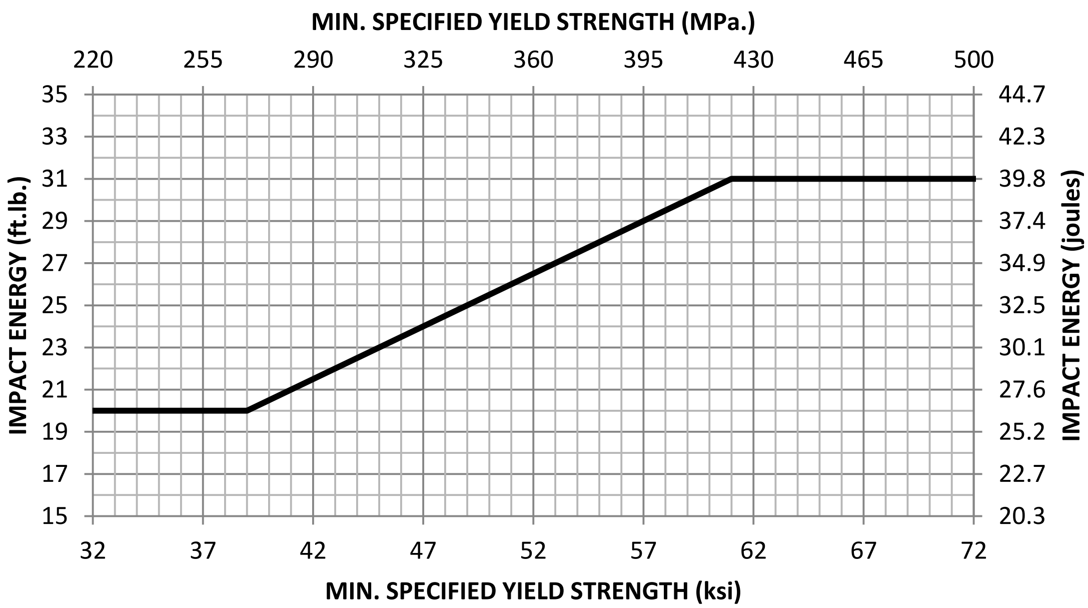


Figure 2—Material Impact Energy for Wrought Steel

Table 6—Impact Test Temperature

Material Thickness (*t*) mm (in.)	**Impact Test Temperature** °C (°F)
t ≤12.7 (t ≤0.5)	T_M + 10 (T_M + 18)
12.7 < t ≤ 25.4 (0.5 < t ≤ 1)	T_M
t > 25.4 (t > 1)	T_M – 20 (T_M – 36)
NOTE 1 Structural steel for primary structural members. NOTE 2 T_M is the nominated minimum operating temperature..	

5.4.10 For base material specimens with their axis transverse to the final rolling direction, the minimum average Charpy values shall be $^2/_3$ of that for the longitudinally oriented specimens. No single Charpy value shall be less than 70 % of the specified value in Figure 2. If standard specimens cannot be made, the required energy values are reduced, as shown in Table 7.

Table 7—Adjustment Factors for Sub-size Impact Specimens

Specimen Dimension mm (in.)	**Adjustment Factor**
10 × 10 (0.39 × 0.39) (full size)	1 (none)
10 × 7.5 (0.39 × 0.30)	0.833

5.4.11 Material with a thickness less than or equal to 6 mm (1/4 in.) shall not be Charpy tested.

5.4.12 Pad eyes should be constructed from special or primary steel meeting API 2H or equivalent. References for acceptance criteria are given in API 2H, DNV-OS-B101, or EN 10164. If the lifting load is transferred through the plate thickness (z-axis), plates with specified (documented) through-thickness properties shall be used.

5.5 Aluminum

5.5.1 The chemical composition, mechanical properties, heat treatment, and weldability shall be satisfactory for the service as well as the fabrication process. Only wrought material, i.e. rolled or extruded, is permitted. Cast aluminum parts are not acceptable. Proper corrosion protection, such as anodizing, shall be considered. Minimum mechanical properties of aluminum alloys and tempers are provided in industry standards such as ASTM B209 and ASTM B221 or equivalent.

5.5.2 Pad eyes should be constructed of materials compatible with the primary structure.

5.5.3 Refer to regulatory requirements for the use of aluminum CCUs in areas classified as hazardous.

5.6 Nonmetallic Material

Timber, plywood, reinforced plastics, and other nonmetallic materials shall not be used in primary structures, but may be used as secondary structures.

Strength, durability, suitability, and possible hazards caused by the use of nonmetallic materials should be evaluated.

5.7 Steel Bolts, Nuts, and Pins

5.7.1 Bolts and pins considered essential for structural integrity and operating safety shall conform to ASTM A193/A193M, ASTM A194/A194M, or ASTM A320/A320M.

5.7.2 For minimum operating air temperatures of 32 °F (0 °C) or higher, Charpy testing is not required. Lot testing may be used for Charpy tests. Nuts are exempt from impact toughness testing. For primary structures, bolting shall meet the Charpy requirements for the primary structure. Materials shall meet the requirements of ASTM A193/A193M with supplemental requirement S2 (Charpy) or ASTM A320/A320M.

5.7.3 Galvanic compatibility shall be evaluated when selecting steel bolts, nuts, and pins for use on aluminum CCUs.

6 Manufacturing

6.1 General

6.1.1 CCU and lifting set production shall be performed in accordance with approved drawings, specifications, and procedures.

6.1.2 The manufacturer shall verify the quality of the procedures and facilities used with the implementation of a quality management system in accordance with API Q1 or ISO 9001.

6.2 Primary Structure

6.2.1 General

Materials for primary structures shall be identified and linked to the corresponding documentation during production. If the marking is not visible on the finished product, the components shall be logged to identify and confirm traceability of the materials used in the primary structure.

6.2.2 Welding Personnel Qualifications

6.2.2.1 Welders shall be qualified in accordance with one of the following as appropriate to the materials being used:

— ASME BPVC, Section IX;

— AWS D1.1;

— AWS D1.2;

— AWS D1.6;

— ISO 9606-1;

— ISO 9606-2.

6.2.2.2 Qualified welding procedures shall be used for the welding carried out on the primary structure.

6.2.2.3 Preliminary welding procedure specifications shall form the basis for the preparation of welding procedure tests.

6.2.2.4 Welding procedure specifications, welding procedure tests, and approval of welding procedures shall be performed in accordance with one of the following as appropriate, and in accordance with 6.2.2.5:

— ASME BPVC, Section IX;

— AWS D1.1

— AWS D1.2;

— AWS D1.6;

— ISO 15607;

— ISO 15609-1;

— ISO 15614-1 and ISO 15614-2

6.2.2.5 Impact tests are required as part of the welding procedure tests. Test temperatures and test results shall conform to the requirements specified in Section 5. For t > 12 mm (0.47 in), four sets of impact tests shall be performed: one set in the weld metal, one set at the fusion line, one set in the heat affected zone (HAZ) 2 mm (0.08 in) away from the fusion line, and one set 5 mm (0.2 in) away from the fusion line.

6.2.3 Examination of Welds

6.2.3.1 Inspection Criteria

6.2.3.1.1 Welds shall be examined in accordance with Table 10.

6.2.3.1.2 The percentages specified in Table 10 shall apply to the total length of weld for the type of structural assembly in question.

6.2.3.1.3 Welds between essential primary structures and nonessential primary structures shall be examined the same between nonessential primary structures.

6.2.3.1.4 When oxy-fuel gas welding is applied, ultrasonic and magnetic particle examinations shall be performed, in addition to radiographic examination.

Table 8—Weld Acceptance Criteria

Visual	Magnetic Particle	Dye Penetrant	Ultrasonic	Radiography
AWS D1.1 or ISO 5817[a]	AWS D1.1 or ISO 23278	AWS D1.1 or ISO 23277	AWS D1.1 or ISO 11666	AWS D1.1 or ISO 10675-1[b]

[a] For aluminum, ISO 10042.
[b] For aluminum, ISO 10675-2.

6.2.3.2 Nondestructive Examination Methods

The nondestructive examination (NDE) methods shown in Table 9 shall be chosen with regard to the conditions influencing the sensitivity of the methods. Structural welds shall be examined as specified in Table 10. The standards listed in Table 8 shall be used for weld acceptance criteria.

Table 9—Standards for NDE Methods

Visual	Magnetic Particle	Dye Penetrant	Ultrasonic	Radiography
AWS D1.1 or ISO 17637	ASTM E125/E125M, ASTM E709, API 2X or ISO 17638	ASTM E165/ E165M, ASTM E433, or ISO 3452-1	ASTM E213, API 2X, or ISO 17640	AWS D1.1 or ISO 17636-1[a] and ISO 17636-2[a]

[a] Class B improved radiographic techniques shall be used.

Table 10—NDE of Structural Welds

Weld Type	Type of Examination		
	I	II	III
	Visual Examination	Magnetic Particle Examination[a]	Ultrasonic Examination[b, e]
Complete joint penetration of primary structure	100 %	100 %[c]	100 %
Fillet welds on primary structure	100 %	20 %[f]	N/A
Fillet welds on secondary structure	100 %	Spot[d]	N/A

a Dye penetrant examination shall be used on nonferrous material.

b Depending on material thickness and accessibility for testing equipment.

c This amount of NDE need not be applied to welds between fork pockets and floor plates or intermediate structure between these. The extent of NDE on these welds will be decided by the surveyor/inspector in each case.

d "Spot" means random examination to the discretion of the surveyor/inspector.

e Ultrasonic examination shall at a minimum be performed following initial load test.

f Refers to the number of welds, not the length of the weld.

6.2.3.3 Nondestructive Examination Personnel Qualifications

NDE operators shall be qualified in accordance with ASNT TC-1A or ISO 9712, to a minimum of Level 2.

6.2.3.4 Welding Documentation

Reports describing weld quality shall contain the following information as a minimum:

a) number of repairs carried out to meet the specified acceptance standard;

b) NDE methods and procedures used;

c) NDE parameters necessary for a proper assessment;

d) confirmation of acceptance or rejection.

6.3 Secondary Structure

6.3.1 The fabrication procedure shall conform to the requirement that the secondary structure shall prevent cargo from falling out of the CCU and, if required, prevent water from entering.

6.3.2 Welds between primary and secondary structures shall be performed as for secondary structures, and shall be examined as such.

6.3.3 The welding procedure used for the secondary structure shall be in accordance with one of the following as appropriate:

— AWS D1.1;

— AWS D1.2;

— AWS D1.6;

— ISO 15607;

— ISO 15609-1;

— ISO 15614-1;

— ISO 15614-2.

7 Prototype Testing

7.1 Prototype Vertical Impact Test

7.1.1 Vertical impact shall be performed on the prototype and can either be physically performed or performed by computerized simulated vertical impact test.

7.1.2 The CCU, with its internal test mass corresponding to working load limit, WLL, shall be either lowered or dropped onto a workshop floor of concrete or other rigid structure. This floor may be covered with a sheathing of wooden planks with a thickness not exceeding 50 mm (1.97 in.).

7.1.3 The CCU shall be so inclined that each of the bottom side and end rails connected to the lowest corner forms an angle of not less than 5° with the floor. However, the greatest height difference between the highest and lowest point of the underside of the CCU corners need not be more than 400 mm (15.75 in.).

7.1.4 The impacting corner shall be the one expected to have the lowest rigidity.

7.1.5 No permanent damage should occur that affects the performance of the unit as determined by the surveyor/inspector.

7.1.6 Cracks in the primary structure welds shall be repaired and the unit shall be retested. Cracks in the secondary structure welds shall be repaired and the unit may be retested.

7.1.7 Deformations that do not impair function may be repaired.

7.1.8 One of the following procedures shall be performed.

a) Vertical impact test; an internal load equal to the working load limit (WLL) shall be safely secured and the CCU shall be inclined as described in 7.1.3. The CCU shall be suspended from a quick-release hook. When released, the CCU shall drop freely for at least 50 mm (1.97 in) to give it a speed at initial impact of at least 1 m/s (3.3 ft/s).

b) Lowering test; an internal load equal to the working load limit (WLL) shall be safely secured and the CCU shall be inclined as described in 7.1.3. The CCU shall be lowered to the floor at a constant speed of not less than 1.5 m/s (4.92 ft/s).

c) A computer simulation following the provisions in item a).

WARNING These tests can cause considerable tremors in the testing facility!

7.2 Prototype Load Testing

7.2.1 General

7.2.1.1 A prototype CCU shall be load tested in accordance with Table 11, to include a nondestructive inspection in accordance with Table 10 before being deemed ready for production.

7.2.1.2 Testing shall not replace design review.

7.2.1.3 Cracks in the primary structure welds shall be repaired and the unit shall be retested. Cracks in the secondary structure welds shall be repaired and the unit may be retested.

7.2.1.4 Deformations that do not impair function may be repaired.

7.2.1.5 For CCUs with special features where additional design requirements apply, suitable tests should be conducted to verify that those requirements are met.

7.2.2 Single Pad Eye Load Testing

Pad eye load testing on CCUs where only the pad eye is subjected to the load shall not be acceptable.

7.2.3 All-point Load Test

The CCU shall be load tested in accordance with Table 11 using all the pad eyes simultaneously.

7.2.4 Two-point Load Test

A two-point load test shall be conducted on each prototype to 1.5 MGW after the manufacturing process is complete.

7.2.5 Post-load Test Inspection and Examination

On completion of the load test, a nondestructive examination and visual inspection of the pad eyes and primary structure shall be performed.

7.3 Failure of Prototype CCUs

In the case of failure of any CCU to conform to either the weld acceptance criteria or the lifting test requirements, the manufacturer shall identify the cause of failure and rectify all affected CCUs. The rectified CCUs shall then be reinspected and/or retested.

8 Production Testing and Inspection Requirements

8.1 CCU Load Testing

8.1.1 CCUs shall be subjected to a load test, along with a proper nondestructive inspection, before being deemed ready for service. CCU pad eyes shall be inspected in accordance with Table 10 prior to any load testing to confirm the equipment is free from any visible defects that would adversely affect the load-testing procedure.

8.1.2 The calculated weight for a load test shall be as shown in Table 11. CCUs shall be load tested in such a way that best simulates the normal loading. The test masses/test load shall be evenly distributed inside the CCU. If it is not possible to place the entire test mass inside the CCU, some of it may be placed outside or under the CCU, provided that this gives a loading on the structure similar to the distribution of the CCU loading in operating condition. Nondestructive examination (NDE) shall be carried out on pad eyes and primary structure after load testing.

8.1.3 For CCUs with special features where additional design requirements apply, suitable tests should be made to verify that those requirements are met.

Table 11—Total Test Load for All-point Lifting Test

MGW	PSL 1 Test Load	PSL 2 Test Load
≤ 25 tonnes (27.5 tons)	2.5 × MGW	2.5 × MGW
>25 tonnes (27.5 tons)	2.0 × MGW	2.5 × MGW
NOTE Intermediate test load values can be interpolated.		

8.2 Load Testing Methods

8.2.1 Load testing shall only be carried out in a manner to minimize damage to the CCUs. A load cell, pressure transducer, or other gauging equipment used shall be affixed to any load-testing apparatus and shall be calibrated annually to ensure the accuracy of the load test. Pad eyes shall be pulled simultaneously to test in the same manner that the unit is normally lifted.

8.2.2 The CCU shall be load tested with a lifting set at an angle equal to the design angle.

8.2.3 The lifting set used in the normal operation of the CCU shall not be used for the load testing of pad eyes on the CCU.

8.2.4 The CCU shall be carefully lifted or loaded in such a way that no significant acceleration forces occur. It shall be held for minimum of five minutes at the test load.

8.3 Single Pad Eye Load Testing

Single pad eye load testing on CCUs where only the pad eye is subjected to the load shall not be acceptable.

8.4 All-point Load Test

The CCU shall be loaded in accordance with the test load prescribed in Table 11 using all the pad eyes simultaneously.

The CCU should show no permanent deformation or other damage after testing.

8.5 Post-load Test Inspection and Examination

On completion of the lifting test, a nondestructive examination and visual inspection of the pad eyes and primary structure shall be performed.

8.6 CCU Load Test Certification

A graph or inspection report shall be prepared by the inspection organization and provided to the manufacturer. The inspection documents shall contain the following information at a minimum:

a) owner of cargo carrying unit;

b) unique identification number;

c) unique load test certificate number and/or unique report number;

d) date, in DD/MMM/YY format (ex. 24 May 13);

e) load applied in pounds or kilograms;

f) tare weight in pounds or kilograms;

g) working load limit or payload in pounds or kilograms;

h) maximum gross weight in pounds or kilograms;

i) inspection organization;

j) serial number and date of calibration of gauging equipment;

k) printed name and signature of inspector performing the load test.

8.7 Calibration/Certification

Annual calibration of all load-testing gauging equipment shall be carried out by experienced personnel in accordance with ASTM E-4, ±1%, traceable to the National Institute of Standards and Technology or other recognized international body and recalibration shall be done yearly. All dead weight/certified weights shall be recertified annually.

8.8 Document Retention

Documents related to the calibration, load testing, and inspection shall be kept by the owner for the retention periods designated in Table 12.

Table 12—Document Retention for Load Testing

Document Type	Retention Period
Gauging equipment	Life of service
Load test report	Life of service
NDT report	Life of service

8.9 Nondestructive Examination of Critical Components

8.9.1 General

Components directly associated with the areas during lifting shall be considered primary structure, and shall be inspected annually in conjunction with pad eye welds.

8.9.2 Nondestructive Examination Procedures

Inspection procedures shall be approved and signed by an ASNT Level III inspector in the qualified methods.

8.9.3 Nondestructive Examination Personnel Qualifications

All inspectors shall be a minimum of ASNT Level II as per SNT-TC-1A or ISO 9712 in the NDT method being used, and shall conform to the training requirements contained within the companies' written training requirements.

8.9.4 Testing and Marking

Prior to initial use, containers shall undergo a load test in accordance with Table 11, and NDT of pad eyes and primary structures in accordance with Table 10. The inspection data plate shall be marked with the suffix “TVN” to indicate the CCU meets the requirements of Table 10.

8.9.5 CCU Failure

In the case of failure of any CCU to conform to either the weld acceptance criteria or the lifting test requirements, the manufacturer shall identify the cause of failure and rectify all affected CCUs. The rectified CCUs shall then be reinspected and/or retested.

9 Cargo Carrying Unit Lifting Sets

9.1 Technical Requirements

Wire rope lifting sets shall be manufactured in accordance with ASME B30.9 or an equivalent international standard. The lifting set is the flexible load-carrying member between the hoisting device and the CCU structure. Each lifting set shall be made of steel core wire rope fabricated with mechanical, Flemish-spliced, or aluminum ferrule turnback eyes, steel-swaged sleeves, heavy-duty thimbles, alloy master links (or alloy master link assemblies). Each lifting set in use with appropriate bolt-type shackles recognized by Federal Specification RR-C-271 or other recognized international standards shall make up a lifting set for CCUs.

9.2 Design Requirements

9.2.1 Design Factors

The design factor against breaking strength for all components of the lifting set shall be a minimum of 5:1. If the design factor is not 5:1, the load rating shall be adjusted accordingly.

NOTE Considerations should be given to operating temperatures.

9.2.2 Rated Loads

The working load limit (WLL) is the rated load capacity of the lifting set. Rated loads for lifting sets are based on the following factors:

— material strength;

— design factor;

— angle of the loading;

— enhancement factor.

Working load limits shall be obtained from Tables 12.1 through 12.4 of the *Wire Rope Sling User’s Manual*, Third Edition.

9.2.3 Enhancement Factor

For the special application of lifting sets fitted to CCUs, the WLL is adjusted using the enhancement factor found in Tables 13 and 14. The minimum working load limit is calculated as follows:

$$\mathrm{WLL}_{\mathrm{min}} = MGW \times EF \tag{25}$$

where:

MGW is the weight of the total system;

EF accounts for the additional dynamic loads to which the lifting set is exposed for the offshore application.

NOTE An MGW less than 2000 kg (4409 lb) should be considered as 2000 kg (4409 lb).

Table 13—PSL 1 Lifting Set Enhancement Factors (3-meter Wave Height)

MGW kg	*MGW* lb	(EF) Single-leg	(EF) Two- and Three-leg	(EF) Four-leg
2000	4409	3.501	3.501	3.501
2500	5512	2.881	2.881	2.881
3000	6614	2.601	2.601	2.601
3500	7716	2.404	2.404	2.404
4000	8818	2.208	2.208	2.208
4500	9921	2.068	2.068	2.068
5000	11,023	1.961	1.961	1.961
5500	12,125	1.874	1.874	1.874
6000	13,228	1.767	1.767	1.767
6500	14,330	1.734	1.734	1.734
7000	15,432	1.701	1.701	1.701
7500	16,535	1.666	1.666	1.666
8000	17,637	1.634	1.634	1.634
8500	18,739	1.601	1.601	1.601
9000	19,842	1.568	1.568	1.568
9500	20,944	1.535	1.535	1.535
10,000	22,046	1.502	1.502	1.502
11,000	24,251	1.458	1.458	1.458
12,000	26,455	1.414	1.414	1.414
13,000	28,660	1.377	1.369	1.369
14,000	30,865	1.359	1.325	1.325
15,000	33,069	1.343	1.281	1.281
16,000	35,274	1.328	1.255	1.255
17,000	37,479	1.315	1.240	1.228
18,000	39,683	1.303	1.228	1.202
19,000	41,888	1.291	1.218	1.175
20,000	44,092	1.281	1.208	1.149
22,000	48,502	1.262	1.190	1.131
24,000	52,911	1.246	1.175	1.114
25,000	55,116	1.239	1.168	1.105
26,000	57,320	1.232	1.162	1.000
28,000	61,729	1.219	1.150	1.000
30,000	66,139	1.208	1.139	1.000
35,000	77,162	1.184	1.116	1.000
40,000	88,185	1.164	1.098	1.000
45,000	99,208	1.148	1.083	1.000
50,000	110,231	1.135	1.070	1.000
70,000	154,323	1.135	1.070	1.000

NOTE Smaller enhancement factors specified in other recognized industry standards may be used if agreed upon between the supplier/manufacturer and the end user/customer.

Table 14—PSL 2 Lifting Set Enhancement Factors (6-meter Wave Height)

MGW kg	*MGW* lb	(EF) Single-leg	(EF) Two- and Three-leg	(EF) Four-leg
2000	4409	3.501	3.501	3.501
2500	5512	3.137	2.957	2.881
3000	6614	2.940	2.772	2.601
3500	7716	2.787	2.628	2.404
4000	8818	2.664	2.512	2.208
4500	9921	2.563	2.416	2.068
5000	11,023	2.476	2.335	1.990
5500	12,125	2.402	2.265	1.930
6000	13,228	2.337	2.204	1.878
6500	14,330	2.280	2.150	1.833
7000	15,432	2.230	2.102	1.792
7500	16,535	2.184	2.059	1.755
8000	17,637	2.143	2.020	1.722
8500	18,739	2.105	1.985	1.692
9000	19,842	2.070	1.952	1.664
9500	20,944	2.039	1.922	1.638
10,000	22,046	2.010	1.895	1.615
11,000	24,251	1.957	1.845	1.573
12,000	26,455	1.911	1.802	1.536
13,000	28,660	1.871	1.764	1.504
14,000	30,865	1.835	1.730	1.475
15,000	33,069	1.803	1.700	1.449
16,000	35,274	1.774	1.672	1.425
17,000	37,479	1.747	1.647	1.404
18,000	39,683	1.723	1.624	1.384
19,000	41,888	1.700	1.603	1.366
20,000	44,092	1.679	1.584	1.350
22,000	48,502	1.642	1.549	1.320
24,000	52,911	1.610	1.518	1.294
25,000	55,116	1.595	1.504	1.282
26,000	57,320	1.581	1.491	1.271
28,000	61,729	1.556	1.467	1.251
30,000	66,139	1.533	1.446	1.232
35,000	77,162	1.485	1.400	1.193
40,000	88,185	1.446	1.363	1.162
45,000	99,208	1.414	1.333	1.136
50,000	110,231	1.387	1.307	1.114
70,000	154,323	1.387	1.307	1.114
NOTE Smaller enhancement factors specified in other recognized industry standards may be used if agreed upon between the supplier/manufacturer and the end user/customer.				

9.2.3.5 The minimum working load limit (*WLL*) for sling leg components and shackles is shown in Table 15.

Table 15—Working Load Limit for Sling Legs and Shackles

Single-leg	Two- and Three-leg	Four-leg
WLL_{min}	$WLL_{\text{min}} / (2 \times \cos \beta)$	$WLL_{\text{min}} / (3 \times \cos \beta)$
β is the angle of the lifting set leg with the vertical.		

9.2.3.6 When designing lifting sets for off-center lifts, the following shall apply:

a) Wire rope diameter and strength shall be selected based on the requirements for the leg handling the greatest load.

b) All sling legs shall have the same strength and diameter as the leg handling the greatest load (exclusive of the stinger/forerunner).

9.3 Lifting Set Manufacturing Methods

9.3.1 General

Components of a wire rope lifting set used for cargo-carrying units shall consist of:

— swage sleeves;

— heavy-duty wire rope thimbles; and

— alloy master links or alloy master link subassemblies.

9.3.2 Wire Rope

Wire rope shall be a six-strand, preformed regular lay consisting of six outer strands with steel core that have been manufactured and tested in accordance with API 9A or an equivalent international standard.

The following apply to wire rope for lifting sets:

a) Wire rope shall be newly fabricated from master reels.

b) Wire rope should be of 6 × 25, 6 × 26, or 6 × 36 construction.

c) Wire ropes should have an equivalent breaking strength to Grade 1960.

d) Wire rope shall be made from a minimum of extra improved plow steel (EIPS)

e) Wire rope shall have an independent wire rope steel core (IWRC)

f) Wire rope shall be drawn galvanized or bright (see API 9A). Stainless steel wire may be used for specialized applications.

9.3.3 Sleeves

Sleeves and swaging process shall be performed in accordance with the applicable standard and manufacturer's recommendation.

The following apply to sleeves for lifting sets:

a) Sleeves shall be of a one-piece design.

b) Flemish eyes shall be mechanically spliced with tapered steel sleeve.

c) Turnback eyes with duplex stainless steel, carbon steel, or aluminum sleeves may be used.

Stainless steel wire ropes with duplex stainless steel sleeves may be used for specialized applications.

9.3.4 Thimbles

Heavy-duty thimbles should be used on all end terminations for improved wire rope life.

9.3.5 Bolt-type Shackles for Lifting Sets

9.3.5.1 Safety anchor shackles are part of the lifting set and shall meet the requirements of Federal Specification RR-C-271 and ASME B30.26, or equivalent international standards. Shackles used in lifting sets shall be adequately sized for the sling leg load, including any enhancement factors.

Materials for shackles used in the lifting set should:

— have a maximum tensile strength of 1180 MPA (171 ksi); and

— have Charpy values of 42 J (31 ft-lb) at –20 °C (–4 °F).

No single Charpy value shall be less than 29 J (21.4 ft-lb).

9.3.5.2 The following criteria apply to lifting set shackles.

a) Shackles shall have a bolt-type, four-piece configuration of body, bolt, nut, and cotter pin or split-ring per manufacturer.

b) Shackles shall meet the performance requirement of U.S. Federal Specification RR-C-271, Type IVA, Grade A, Class 3, or equivalent specification.

c) Shackle bows, and bolts with a galvanized finish, shall be in accordance with ASTM A153/A153M.

d) Shackles shall meet ASME B30.26 requirements or equivalent international standard.

e) Shackle bows and bolts shall have a traceability code.

f) The working load limit shall be permanently marked on all shackle bows.

g) All shackles in the lifting set for cargo carrying units shall be of the same manufacturer, type, size, and working load limit.

h) Welding on shackles is not acceptable.

i) Shackles are considered part of the lifting set, and therefore shall be included on the certification documentation. Alternatively, individual certification of the shackle is acceptable if the certification is referenced to the lifting set certification, and the shackles are of the same size, *WLL*, manufacturer, and type.

j) Shackles that are marked shall be marked using low-stress stamps. Stamping shall be legible at the manufacturer's specified area of the shackle. Shackles should be tagged by fitting an identification tag with a wire loop and duplex sleeve on the body of the shackle. Shackles that are captivated to the sling are not required to be stamped or tagged; however, they shall be documented and included on the certification of the lifting set load.

9.3.6 Master Links and Master Link Subassemblies

9.3.6.1 Alloy master links and master link subassemblies shall meet the requirements of ASME B30.26 or EN 1677-4. Alloy master links and master link subassemblies used in lifting sets shall be adequately sized for the lifting set load.

9.3.6.2 Materials for master links/master link subassemblies used in the lifting set shall:

— have a maximum tensile strength of 1180 MPa (171 ksi); and

— Charpy values of 42 J (31 ft-lb) at –20 °C (–4 °F).

No single Charpy value shall be less than 29 J (21 ft-lb).

For welded links, Charpy values in the weld fusion line shall be 27J (20 ft-lb) at –20 °C (–4 °F).

The minimum average impact energy of the weld shall be 27 J (20 ft-lb) at –20 °C (–4 °F).

9.3.6.3 The following apply to master links and master link subassemblies for lifting sets.

a) Alloy master links and master link subassemblies shall have a traceability code and be proof load tested from the manufacturer prior to first use as per ASME B30.26 or an equivalent international standard.

b) Master links and master link subassemblies shall have shape and dimension to give the wire rope thimble eyes adequate clearance to allow free movement in the link.

c) Four-leg lift sets should use master link subassemblies.

9.3.7 Wire Rope Forerunner (Single-leg Stinger)

9.3.7.1 Forerunners are single-leg wire rope appendages that can be attached to an existing multi-leg wire rope lifting set. Forerunners shall be in accordance with ASME B30.9 or EN 13411-1, EN 13411-2, and EN 13411-3.

9.3.7.2 Each forerunner shall meet or exceed the *WLL* of the lifting set.

9.3.7.3 The forerunner shall be at 90 degrees to the horizontal.

9.3.7.4 Table 16 provides minimum leg lengths of forerunners.

Table 16—Forerunner Lengths

Diameter of Wire Rope	Minimum Leg Length
$^{1}/_{2}$ in.	2 ft
$^{9}/_{16}$ in.	2 ft, 2 in.
$^{5}/_{8}$ in.	2 ft, 4 in.
$^{3}/_{4}$ in.	2 ft, 9 in.
$^{7}/_{8}$ in.	3 ft, 3 in.
1 in.	3 ft, 6 in.
1 $^{1}/_{8}$ in.	4 ft
1 $^{1}/_{4}$ in.	4 ft, 6 in.
1 $^{3}/_{8}$ in.	5 ft
1 $^{1}/_{2}$ in.	5 ft, 6 in.
1 $^{5}/_{8}$ in.	6 ft
1 $^{3}/_{4}$ in.	6 ft, 6 in.
2 in.	8 ft
2 $^{1}/_{4}$ in.	8 ft, 9 in.
2 $^{1}/_{2}$ in.	10 ft

9.3.8 Fabrication Methods

Methods of fabrication of wire rope slings, forerunners, and single-leg stingers shall be in accordance with ASME B30.9 or EN 13411-1, EN 13411-2, and EN 13411-3, using steel core wire rope fabricated with mechanical, Flemish-spliced, or aluminum ferrule turnback eyes, steel-swaged sleeves, heavy-duty thimbles, and alloy master links (or alloy master link subassemblies).

a) Wire rope clips shall not be used to fabricate CCU wire rope slings.

b) Knots shall not be used to fabricate CCU wire rope slings.

c) A certificate of proof test shall only include one unique lifting set.

d) Each wire rope lifting set shall be marked in accordance with 9.9.

9.3.9 Proof Load Testing

The lifting set shall be proof load tested to two times the working load limit ($2 \times WLL$) of each leg after manufacturing.

9.4 Lifting Set Identification Requirements

9.4.1 Lifting sets shall be marked with an identification sleeve or tag permanently attached to the top assembly of the lifting set. The sleeve or tag shall be permanently embossed or stamped.

9.4.2 The marking on sleeves or tags for wire rope lifting sets shall include the following:

a) "API 2CCU PSL-(n)"—where (n) is the applicable PSL number;

b) manufacturer's name;

c) rated load for angle of sling 45, 30, or 0 degrees from the vertical configuration, or 45, 60, or 90 degrees from the horizontal configuration;

d) wire rope diameter;

e) lifting set leg length(s);

f) original manufacture date;

g) certification number;

h) certificate date.

9.5 Removal Criteria for Wire Rope Lifting Sets

Wire rope lifting sets shall be removed from service based on the removal criteria in API 2D, ASME B30.9, or equivalent international standard.

9.6 Removal Criteria for Bolt-type Shackles

Shackles shall be removed from service from the lifting set based on the removal criteria in API 2D, ASME B30.26. or equivalent international standard.

9.7 Repairs to Wire Rope Lifting Sets

Wire rope lifting sets shall be repaired only by the manufacturer or qualified person, and shall be in accordance with ASME B30.9 or an equivalent international standard.

Wire rope lifting sets that are repaired shall be identified, and proof load tested to twice the working load limit per ASME B30.9 or equivalent international standard prior to first use.

9.8 Lifting Set Certificates

9.8.1 Lifting sets shall be issued with a certificate by the lifting set manufacturer that contains the information specified as follows, as a minimum:

a) "API 2CCU PSL-(n)"—where (n) is the applicable PSL number;

b) manufacturer's name, mark, and contact location;

c) date of issue for the certificate;

d) lifting set certificate number;

e) description of the lifting set, including unique identification number or mark, the grade of wire rope, and grade of the terminal fittings;

f) reference to each single component's unique identification mark, if applicable. If new components are installed before re-certification, reference to the previous certificate's number and the new component's unique identification mark.

g) working load limit (*WLL*) with the appropriate angle to the vertical or horizontal for multi-leg lifting set and the method of rating.

h) date of lifting set manufacture;

i) manufacturer's authorized signature.

9.8.2 The lifting set certificates shall be retained by the manufacturer/owner in accordance with Table 20.

10 CCU Marking Requirements

10.1 Safety Marking

The tops of closed CCUs and the top rails of open and framed CCUs shall be marked as follows:

a) Open, closed, and framed units shall be marked with a band of solid high-visibility contrasting color not less than 76 mm (3 in.) or greater on the top rails, or 51 mm (2 in.) highly reflective tape.

b) Where a unit is fitted with fork pockets designed for handling the unit only when empty (e.g. long baskets), the words "Empty lift only" shall be clearly displayed near each set of fork pockets.

c) If the removal of a primary structure(s) is possible, and is designed to be installed prior to lifting, the CCU shall be marked to indicate this condition. The marking shall also indicate that the movable or removable parts shall be in place before lifting.

d) CCUs with flexible top protection shall be marked with "NO STEP" in black letters of not less than 100 mm (4 in.) in height on a yellow background, and with the prohibition sign in accordance with ISO 7010, P024.

Pad eyes should be designated as lifting eyes by paint, sticker, etc.

10.2 CCU Identification Markings

10.2.1 Each unit shall be marked with a unique CCU identification number issued by the owner or manufacturer.

10.2.2 The CCU identification number, tare, *WLL*/payload, and *MGW* shall be permanently marked on the CCU.

10.2.3 The CCU identification number shall be prominently and indelibly displayed on all sides of the CCU (as viewed from ground level) in characters of a contrasting color (if welded).

10.2.4 If a unit has a roof, the CCU identification number shall be displayed on the roof at a minimum of 305 mm (12 in.). Where character size is restricted by the available space, the CCU identification number should be as large as practical. The marking shall be carried out in such a way as to avoid incorrect interpretation (e.g. by underlining). Where applicable, the lower edge of the marking shall be positioned near the side of the CCU in which the door is located.

10.2.5 An area on the side of the CCU for the attachment of end-user certification or information and is defined as a black box. This should be 305 mm × 305 mm (12 in. × 12 in.) or of sufficient size if space constricted.

10.3 Manufacturer's Data Plate Marking

10.3.1 General

10.3.1.1 CCUs manufactured in accordance with this standard shall have a manufacturer's data plate securely attached in a visible location. The means used to secure the data plate to the CCU shall be free of potential snag hazards.

10.3.1.2 The plate shall be made of corrosion-resistant material securely attached externally in a manner designed to avoid unauthorized or accidental removal. The plate shall be fitted to a door; for CCUs with no doors, the plate shall be securely attached in a prominent position.

10.3.1.3 The manufacturer's data plates shall be stamped or etched, and markings shall not be less than 3 mm ($^{1}/_{8}$ in).

10.3.2 Manufacturer's Data Plate Information

The following information shall be present on each data plate:

a) manufacturer's name and address;

b) manufacturing date;

c) owner's name and address;

d) identification number [API 2CCU-PSL (n), where (n) is the applicable PSL number];

e) maximum gross weight (MGW);

f) tare weight;

g) payload;

h) mid-deck weight (if applicable);

i) product specification level (PSL);

j) design temperature;

k) inspection legend;

l) test history (see example below);

EXAMPLE 14 Feb XX – TVN; 14 Aug XX – V; 14 Feb XX – VN; where T = load test, V = visual examination, and N =NDE.

10.4 Cargo Carrying Unit Inspection Plate

10.4.1 General

10.4.1.1 CCUs shall be fitted with an inspection plate carrying the information specified in 10.4.2.

10.4.1.2 The plate shall be made of corrosion-resistant material securely attached externally in a manner designed to avoid unauthorized or accidental removal. The plates shall be securely attached to a door; for CCUs with no doors, the plate shall be securely attached in a prominent position.

10.4.1.3 The static information shall be permanently and legibly marked on the plates in characters not less than 3 mm ($^1/_8$ in.) high.

10.4.2 Inspection Plate Contents

10.4.2.1 The inspection plate shall have the heading "OFFSHORE CARGO CARRYING UNIT INSPECTION PLATE – API 2CCU."

10.4.2.2 The plate shall contain the following information:

— owner's CCU number/serial number;

— owner's name;

— testing organization and address;

— date of last inspection.

10.4.2.3 The date of last inspection shall be the date on which the most recent inspection was performed and approved by the qualified inspector.

10.4.2.4 The inspection plate may be combined with the data plate by including the additional information specified in 10.3.

11 Documentation

11.1 Certificate of Conformance

Upon successful completion of fabrication, inspection, and testing, the qualified person shall provide the purchaser with a certificate of conformance (COC) stating that the CCU conforms to the current edition of this standard.

The COC shall be retained by the manufacturer for the life of the equipment/CCU. The COC shall be based on the as-built dossier and data package. The COC shall include signatures of the appropriate personnel in accordance with Table 17.

Table 17—Authorized COC Signatures

COC Item	Authorized Signatory
Structural calculations	Design engineer
Design drawings	Design engineer
Welding procedure specifications (WPS)	Design engineer
Welder qualifications/certificates	Fabricator
Material certificates	Fabricator
Material traceability record for primary structure	Fabricator
Inspection record for fabrication	Fabricator and inspection organization
Dimensional control record	Fabricator
Nondestructive examination (NDT) certificate/report	Inspection organization
Prototype test report (if required)	Inspection organization
Proof testing certificates for CCU and lifting set	Inspection organization
Final inspection records/ full data package	Manufacturer, COC sign-off

12 Periodic Testing, Inspection, and Maintenance

12.1 Cargo Carrying Unit Inspections

12.1.1 General

CCUs shall be inspected after being placed in service by an inspection organization in accordance with frequencies shown in Table 18.

Table 18—Periodic Inspection Cycle and Tests for Cargo Carrying Units

Inspection Cycle	Type of Inspection			Suffix[b]
	Load Test (T)	NDT of Pad Eyes and Primary Structure (N)	Visual Inspection (V)	
Annually (12 months)	N/A	Yes	Yes	VN
Every five years	Yes	Yes	Yes	T
After repair to pad eyes/primary structure[c]	Yes	Yes[a]	Yes	T

NOTE Eddy current can be performed at the discretion of the qualified person if coating is present

[a] UT shall be performed in accordance with Table 8 and Table 10.

[b] To be marked on the plate.

[c] A substantial repair or alteration means any repair and/or alteration carried out that may, in the opinion of a competent person, affect the load-bearing elements of the container, or elements that contribute directly to its structural integrity.

Key

T = Load test; V = Visual inspection; N = NDT inspection

12.1.2 Load Testing (Five-year Inspection)

CCUs shall be load tested prior to being put into initial service after any hot-work repair to the primary structure and five years from the prior load test.

12.1.3 Nondestructive Testing (Annual Inspection)

12.1.3.1 General

Primary structures and pad eye welds shall be nondestructive tested in accordance with Table 18 after load testing or on an annual basis until the next load-testing cycle. Primary structure shall include, but is not limited to, posts (top and bottom) where pad eyes are fitted and other vertical posts in between pad eye posts.

12.1.3.2 Eddy Current Inspection

Eddy current inspection is acceptable and can be used on painted surfaces. Painted surfaces that are to be inspected shall be free from damage. Surfaces that are rough or damaged may not be conducive to the eddy current method.

Eddy current testing is a recognized NDT method that has the advantage that it can be performed without stripping off the paint on a welded connection. Personnel performing eddy current testing shall be qualified to ET level II or III in accordance with ASNT SNT-TC-1A or ISO 9712 or other equivalent internationally recognized standard.

If indications are found during the eddy current inspection, the paint shall be stripped off and the weld shall be inspected by means of the relevant NDT method and the applicable acceptance criteria.

12.2 Lifting Set Inspection

12.2.1 Inspection Cycles

The inspection cycles for in-service lifting sets shall be in accordance with Table 19.

Table 19—Inspection Cycle and Tests for Lifting Sets

Inspection Cycle	Type of Inspection		
	Proof Load Test	NDT Master Link/Sub-link Assembly	Visual
Annually (12 months)	N/A	N/A	Yes[a]
Every five years (60 months)	Yes[b]	Yes	Yes[b]
After repair or major alteration to lifting set[c]	Yes	N/A	Yes

NOTE Marking of lifting sets shall be in accordance with 10.9.

[a] The inspector may require other inspections or tests if indicated after visual inspection.

[b] If a proof load test and visual inspection are successfully completed by a qualified person, removal from service is not mandatory.

[c] If more than 51 % of lifting set legs require rebuild, all legs shall be changed on the lifting set.

12.2.2 Visual Inspection of the Lifting Set

12.2.2.1 General

The inspection shall be carried out by a qualified person with normally corrected vision, in a situation providing sufficient lighting and other facilities necessary to allow it to be carried out safely and effectively.

12.2.2.2 Wire Rope and Components

Inspection of wire rope slings and components shall be performed in accordance with ASME B30.9 and ASME B30.26 or EN 818-6 and EN 13414-2, as applicable.

12.2.2.3 Shackles

Shackles shall be visually inspected.

12.2.3 Master Link/Sub Link Assemblies

12.2.3.1 Master link/sub link assemblies shall be proof tested to a minimum of two times the rated load (WLL). This shall occur prior to initial use by the manufacturer or qualified person and subsequently every five years from when the lifting set/master link/sub assembly was put into service.

12.2.3.2 Master links/sub link assemblies that are proof tested at the five-year mark shall be inspected in accordance with ASME B30.26. Inspection shall include a visual inspection and an MT or PT inspection with acceptance criteria in accordance with ASTM A952/A952M.

12.2.3.3 Master link/sub link assembly information shall be recorded on the lifting set proof test report, and shall state at a minimum the following information:

a) name of the manufacturer;

b) evidence of conformance to ASTM A952/A952M and year of issue;

c) size of component, in. (mm);

d) grade of component;

e) class of component;

f) quantity and description of the component;

g) proof test force applied, lb (kN);

h) working load limit of the component, lb (kg).

12.2.4 Inspection Report

12.2.4.1 General

When the CCU is deemed suitable for service by the qualified inspector, an inspection report shall be issued to the owner containing the following information (at a minimum):

a) CCU identification (including owner's CCU number);

b) sling and shackle identification numbers;

c) owner’s name or delegated nominee;

d) report number;

e) statement that the lifting equipment described was inspected, examined, and tested, is safe to operate, and that the particulars are correct;

f) weights of the tare, payload, and maximum gross weight (maximum gross mass) in kg or lb, and the method of test;

g) details of NDT performed;

h) confirmation that the inspection plate and sling identification tag was marked; date of inspection (date of signature or report also to be shown if different from date of inspection);

i) name of inspection organization, including the name of the person and authentication by the person carrying out the inspection/examination or test, either by signature or other secure means;

j) comments on any limits to the scope of inspection.

Details of the examination of the lifting set may also be given on the Inspection Report for the CCU.

This report may be combined with the initial certificate of conformance.

12.2.4.2 Damage and Repair Procedures

The owner shall confirm the following:

a) The lifting set is maintained in accordance with Section 9.

b) If the lifting set is damaged, it shall be removed from service until it is repaired or replaced, and inspected by a qualified person.

c) Lifting set repairs are carried out in accordance with the requirements in Section 9.

d) Repair facilities shall verify the quality of the procedures through the implementation of a quality management system in accordance with API Q1 or ISO 9001.

e) The lifting set is inspected following repairs in accordance with Table 20. The repair facility shall provide the owner with details of the repairs that have been carried out. Lifting sets shall be recertified after undergoing modification(s).

12.2.4.3 Document Retention

For traceability, inspection records shall be retained by the owner in accordance with periods listed in Table 20.

Table 20—Document Retention Periods for Inspection Records

Document Type	Retention Period
NDT inspection certificates	Life of service
Initial lifting set manufacture proof test certificate	Life of service
Initial shackle proof test certificate	Life of service
Yearly lifting set recertification certificate	Life of service

12.2.5 Recertification

Recertification of lifting sets shall be performed by a qualified person by means of a visual exam as specified in Table 19. Lifting set legs with evidence of a failed inspection shall be destroyed by cutting the eye to prevent further use.

12.3 Maintenance

12.3.1.1 Preventative Maintenance

A preventative maintenance program shall be developed by the manufacturer or owner, taking into consideration unit type, frequency of use, history of maintenance, and manufacturer's recommendations. The manufacturer shall provide recommendations on preventative maintenance to the owner. Documented and dated maintenance records should be available for a period of five years.

12.3.1.2 Maintenance Procedure

12.3.1.2.1 Maintenance is a combination of technical, administrative, and managerial measures taken through the life of a CCU. Maintenance is done with the aim of sustaining the condition of the equipment so it can perform the intended function.

12.3.1.2.2 Maintenance procedures should be developed and improved continuously based on experiences made during the operation and historical maintenance of the unit.

12.3.1.2.3 Before carrying out maintenance, controls should be in place to prevent injury to personnel.

12.3.1.2.4 Before the CCU is put into service, the person responsible for the operational activity shall confirm that all testing has been carried out in accordance with 8.1.

12.3.2 Routine Maintenance

Routine maintenance is a key element in maintaining the integrity of CCUs. Good routine maintenance practices can prevent premature failure. The following should be considered when completing routine maintenance:

— cleaning;

— framework;

— walkways;

— ladders;

— paint work;

— redundant labels;

— marking.

12.4 Failure of In-service CCUs

If a CCU fails to conform to the requirements of this standard, a nonconformance report shall be issued. The CCU shall be reinspected and/or retested in accordance with Table 10 and Table 11 after the nonconformance is rectified.

Annex A
(informative)

Assessment Criteria for Existing Cargo Carrying Units

A.1 The purpose of this annex is to provide the operator or end user with assessment and acceptance criteria for fit-for-purpose CCU equipment that has been placed in service. Equipment shall not be marked as API 2CCU compliant unless it can be demonstrated to be in full compliance with all requirements of Clauses 2 through 12 and A.3.

A.2 As an example, within the U.S. Gulf of Mexico (GoM), in-service CCU equipment should meet GoM Operator fit-for-purpose lifting acceptance standards—collectively known as “Gulf of Mexico Lift Design”—set forth by operators in the Gulf of Mexico. For other regions, see local CCU lifting standards for this definition.

A.3 CCUs that have been placed in service shall be assessed and confirmed to meet the minimum requirements as follows:

a) engineered drawings, with the AISC Steel Construction Manual or international design and analysis calculations, verified and stamped by a licensed professional engineer, a class society, or a recognized regional authority;

b) welding procedures;

c) welder certifications;

d) material test reports (MTRs);

e) procedures for construction and inspection;

f) documented test history;

g) pre-load test inspection to include primary structures and pad eyes;

h) marked with all load ratings;

i) load tested to 2.5 times the maximum gross weight (MGW) in accordance with the standard to which the CCU was constructed;.

j) post-load test NDE shall include primary structures and pad eyes;

k) working load limit (WLL) of lifting set shall exceed the MGW of the CCU by a factor of 1.3.

A.4 in-service CCUs shall meet or exceed current fit-for-purpose lifting standard criteria as determined by an operator or end user in the region that the CCU equipment is accepted and in use.

Bibliography

[1] API Specification 2H, *Specification for Carbon Manganese Steel Plate for Offshore Platform Tubular Joints*

[2] ASTM A516/A516M, *Standard Specification for Pressure Vessel Plates, Carbon Steel, for Moderate- and Lower-Temperature Service*

[3] ASTM A572/A572M, *Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel*

[4] ASTM B209, *Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate*

[5] ASTM B221, *Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes*

[6] DNV[9]-OS-B101, *Metallic Materials*

[7] EN 10164, *Steel products with improved deformation properties perpendicular to the surface of the product. Technical delivery conditions*

[8] ISO 1161, *Series 1 freight containers — Corner and intermediate fittings — Specifications*

[9] IMO[10] MSC/Circ. 860, *Guidelines for the approval of offshore containers handled in open seas*

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[9] DNV-GL, Veritasveien 1, 1363 Høvik, Norway, www.dnv-gl.com.

[10] International Maritime Organization, 4, Albert Embankment, London, SE1 7SR, UK, www.imo.org.

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