Offshore Cargo Carrying Units

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Foreword

The verbal forms used to express the provisions in this standard are as follows:

— the term “shall” denotes a minimum requirement in order to conform to the standard;

— the term “should” denotes a recommendation or that which is advised but not required in order to conform to the standard;

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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.

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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.

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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.

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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

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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.

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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;

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— 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

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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.

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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.

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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:

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

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:

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

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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.

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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.

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