Excerpt from ABS Rules Developed for Jacking and Associated Systems

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Excerpt from ABS Rules Developed for
Jacking and Associated Systems

American Bureau of Shipping

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Foreword

Purpose

This booklet is an excerpt from the ABS Rules. It has been created to support equipment manufacturers in identifying the appropriate ABS Rules for their products.

Application

Equipment manufacturers seeking to have their products approved for marine and offshore applications under ABS classification or certification will find this booklet a practical reference for determining which sections of the ABS Rules are applicable to their specific equipment types.

This excerpt does not replace or supersede the complete ABS Rules. Users are responsible for consulting the full text of the applicable Rules and ensuring compliance with the most current edition, including any published corrigenda and notices.

Additional Information

For questions regarding the applicability of specific Rules to your equipment. Please contact your local ABS office.

The ABS Rules are available in their complete form at American Bureau of Shipping (ABS) Eagle.org.

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An operating manual which is consistent with the information and criteria upon which classification is based is to be placed aboard the unit for the guidance of the operating personnel. The primary language of the Operating Manual is to be English. Units not meeting the criteria of 3A-1-3/1.3 and 4-1-1/7.7 of the *Offshore Rules* for unrestricted service are to have the notation *Restricted Service – Elevated Condition* or *Restricted Service – Afloat Condition* and details of the service restrictions are to be placed in the Operating Manual. Insofar as classification is concerned, the operating manual is to include the following details:

1.1

A general description of the unit, including major dimensions, lightship characteristics.

1.3

Summaries of each of the approved modes of operation (see 3A-1-1/17 of the *Offshore Rules*):

i. Limiting environmental conditions, including wave height and period, wind velocity, current velocity, service temperature of the unit (see 3A-1-1/25 of the Offshore Rules), minimum expected sea temperature, seabed penetration, spud can-soil stiffness, air gap, and water depth

ii. Design deck loadings, mooring loads, icing loads, variable loads, total elevated load, cantilever loads, rated capacities of derricks (if applicable), cranes and elevating systems and types of helicopters for which the helideck is designed

iii. Draft or draft range, leg length, spud can position and whether buoyant or non-buoyant, disposition of movable equipment (see 3A-3-2/3.1 of the Offshore Rules) such as cantilevers, drilling masts (if applicable), crane booms, etc.

iv. Maximum allowable KG versus draft curves or equivalent and associated limitations or assumptions upon which the allowable KG is based

v. Disposition (open or closed) of watertight and weathertight closures (see 3A-3-2/5 of the Offshore Rules)

vi. Identification of “Restricted Service” conditions

1.5

Plans/documentation showing:

i. General arrangements

ii. Preload capacity (see 3A-1-3/1.11 and 3A-2-3/5.7 of the *Offshore Rules*)

iii. Watertight and weathertight boundaries, locations of unprotected openings and watertight and weathertight closure

iv. Type, location, and quantities of permanent ballast

v. Allowable deck loadings (see 3A-1-3/1.11 of the *Offshore Rules*)

vi. Capacity, centers of gravity, and free surface correction for each tank

vii. Capacity and centers of gravity of each void provided with sounding arrangements but not provided with means of draining (see 3A-3-2/2.3.4(a) of the Offshore Rules)

viii. Location and means of draining voids, as specified in 4-2-4/3.3 of the *Offshore Rules*

ix. Hydrostatic curves or equivalent

x. Hazardous areas (see Section 4-3-6 of the *Offshore Rules)*

xi. Simplified electrical one-line diagrams of main power and emergency power systems

xii. Schematic diagrams of the bilge, ballast, and ballast control system

1.7

Ballasting procedure(s) as specified in 4-2-4/13.1 of the *Offshore Rules.*

1.9

Recommended sequence of emergency shutdowns as specified in 4-3-5/7 of the *Offshore Rules.*

1.11

Procedure for elevating and preloading.

1.13

Loading and KG worksheets, sample calculations for each mode of operation and instructions for their use. Worksheets and instructions are to include guidance for the routine recording of lightweight alterations.

1.15

A description of the specific locations on the unit where equipment brought onboard for the purpose of conducting well test operations is to be placed and any action that needs be taken to safely accommodate this equipment.

1.17

Procedures and/or arrangements for confirming engagement and full disengagement status of fixation system, where such systems are used.

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The Operating Manual is to be submitted for review by ABS solely to verify the presence of the above information which is to be consistent with the design information and limitations considered in the unit's classification. ABS is not responsible for the operation of the unit.

The Operating Manual required by this Section does not need to be in addition to that required by flag and coastal Administrations. These administrations may require that additional information be included in the Operating Manual.

25 Service Temperature *(1 July 2025)*

The service temperature of the unit refers to the minimum temperature of the steel in all modes of operation and is to be taken as the lowest mean daily average air temperature based on available meteorological data for anticipated areas of operation, as well as transit conditions to the area of operation after construction.

Temperatures experienced during the construction phase of the unit are not to be considered as service temperature.

Commentary:

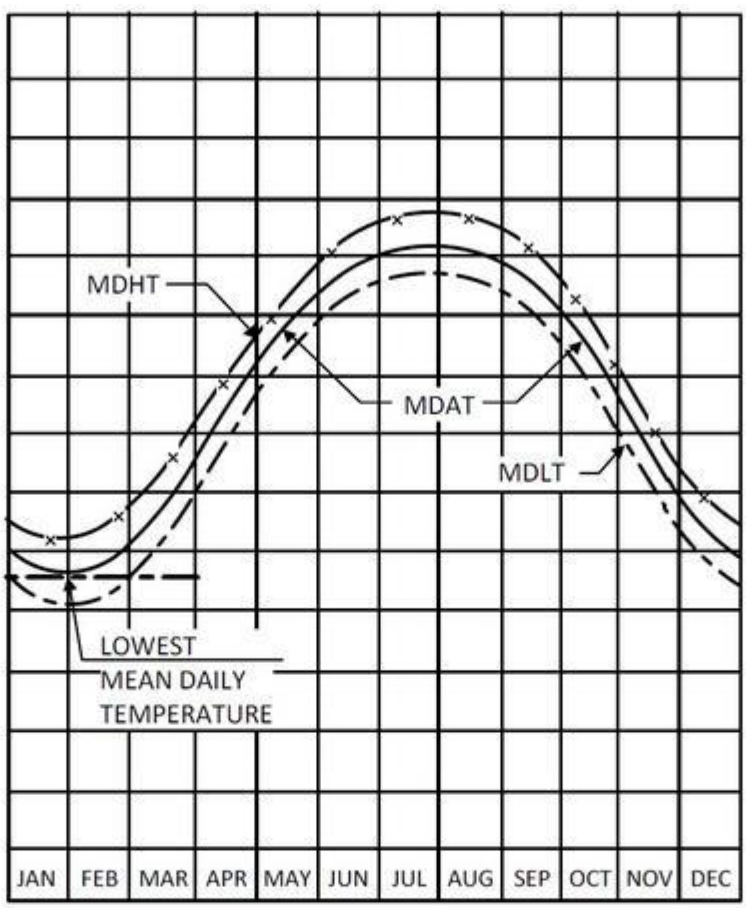
It is recommended to monitor the temperature experienced during the construction phase, particularly in critical structural areas, when temperatures fall outside the designated service temperature range.

End of Commentary

- Lowest: Lowest of the mean daily average temperatures during the year (see 3A-1-1/Figure 1)
- Mean: Statistical mean of daily average values over observation period (at least 20 years)
- Daily average: Average air temperature during one day and night

For seasonally restricted service, the lowest value within the period of operation applies.

FIGURE 1
Commonly Used Definitions of Temperatures



MDHT = Mean Daily High (or maximum) Temperature

MDAT = Mean Daily Average Temperature

MDLT = Mean Daily Low (or minimum) Temperature

1 Hull and Design Data *(1 July 2025)*

Plans showing the scantlings, arrangements, and details of the principal parts of the structure of each unit to be built under survey are to be submitted for review and approved before the work of construction is commenced. These plans are to clearly indicate the scantlings, joint details and welding, or other methods of connection.

The following symbols are used in this Section for the type of review of the documents:

R: Documents to be reviewed

I: Documentation for information and verification for consistency with related review

OB: Documentation which needs to be kept on board

The following plans, where applicable, are to be submitted.

- General arrangement **(R)**
- Inboard and outboard profile **(I)**
- An arrangement plan of watertight compartmentation **(I)**
- Diagrams showing the extent to which the watertight and weathertight integrity is intended to be maintained, including the the location, type and disposition of watertight and weathertight closures. **(R)**
- Summary of distributions of fixed and variable weights for each reviewed condition. **(I)**
- Type, location, and quantities of permanent ballast. **(R)**
- Loadings for all decks **(I)**
- Transverse sections showing scantlings **(R)**
  Longitudinal sections showing scantlings **(R)**
- Decks **(R)**
- Structural fire protection layout plan for decks and bulkheads **(R)**
- Fiber Reinforced Plastic (FRP) layout drawing **(R)**
- Structure categorization plan with detailed information of special, primary, and secondary application structures, including internal members attached to the structures. Refer to 3A-2-3/3.1, 3A-2-4/1.7, and 3A-2-5/3. **(R)**
- Plans or a booklet of joiner work details of construction for all decks, bulkheads, and doors **(R)**
- Ventilation plan showing all horizontal and vertical duct work listing all materials, duct size, and gauge **(R)**
- Penetration details through bulkheads and decks to accommodate ventilation, piping, electrical, etc. **(R)**
- Escape plan (depicting escape routes as determined by 5-3-1/3) **(R)**
- Helicopter deck with helicopter particulars and its supporting structure (See 3A-2-2/3.1) **(R)**
- Framing **(R)**
- Shell plating **(R)**
- Watertight bulkheads and flats **(R)**
- Structural bulkheads and flats **(R)**
- Tank bulkheads and flats with level of top of overflows and air pipes **(R)**
- Pillars and girders **(R)**
- Diagonals and struts **(R)**
- Legs , footings, spudcans, pads, or mats **(R)**
- Structure in way of jacking or other elevating arrangements and, as applicable, leg fixation systems **(R)**
- Structures supporting the drilling derrick (including the substructure and cantilever) **(R)**
- Stability columns and intermediate columns **(R)**
- Hulls and pontoons **(R)**
- Superstructures and deck houses **(R)**
- Arrangement and details of watertight doors and hatches **(R)**
- Foundations for anchoring equipment, industrial equipment, etc., where attached to hull structure, superstructures, or deckhouses Welding details and procedures **(R)**
- Lines and offsets **(I)**
- Curves of form or equivalent data **(I)**
- Wind heeling moment curves or equivalent data **(I)**
- Capacity plan **(I)**
- Tank sounding tables **(OB, I)**

- Stability Test Procedure **(R)**
- Stability Test Results or Lightweight Survey Results **(R, OB)**
- Corrosion control arrangements **(R)**
- Methods and locations for nondestructive testing **(I)**
- Plans for conducting underwater inspections in lieu of drydocking **(R)**
- A description of environmental conditions for each mode of operation, including the service temperature of the unit (see 3A-1-1/25) and minumum expected sea temperatures **(I)**
- Onboard Software for Stability Calculations - Operation Manual **(R, OB)**
- Operating Manual as required by Section 1-2-5 **(R, OB)**

5 Selection of Grades

5.3.2 Primary Application (Intermediate)

Failure of primary application structural elements may cause significant structural damage to the unit with moderate risk of loss of life and environmental pollution. The primary application structural elements have an intermediate criticality for the survivability of the unit.

5.3.3 Secondary Application (Least Critical)

Failure of secondary application structural elements may cause minor structural damage to the unit with low risk of loss of life and environmental pollution. The secondary application structural elements are the least critical for the survivability of the unit.

5.5 Selection Criteria for ABS Grades of Steel

3A-1-4/Table 1 shows selection criteria for each structural element category for ABS grades of ordinary and higher strength hull structural steels to be used in self-elevating and column-stabilized units expected to experience service temperatures as low as –30°C (–22°F). Requirements for selection of ABS extra high strength steels are given in 3A-1-4/Table 2. Service temperature refers to the minimum temperature of the steel. See 3A-1-1/25. Where the steel temperature in specific structural areas is shown to be warmer than the service temperature of the unit, the warmer temperature may be applied. Where the minimum steel temperature is 0°C (32°F) or warmer, the material requirements indicated for 0°C (32°F) are generally applicable. In addition, where material being considered is located in close proximity to, or below, the minimum waterline, the material selection may be based on that indicated for the 0°C (32°F) temperature.

These requirements are applicable for units that are limited to areas of operation where ice strengthening is not required.

Where it is desired to use steels other than those in 3A-1-4/Table 1 and 3A-1-4/Table 2 or thicknesses above the maximum indicated in 3A-1-4/Table 1, they are to be specially considered.

5.7 Criteria for Other Steels

5.7.1 General

Appropriate supporting information or test data is to indicate that the toughness of the steels will be adequate for their intended application in the unit's structure at the service temperature of the unit. In the absence of supporting data, tests are required to demonstrate that steels would meet the following Charpy V-Notch (CVN) impact requirements.

5.7.2 CVN Requirements

Steels in the 235 to 420 N/mm^2 (24 to 43 kgf/mm^2, 34 to 61 ksi) yield strength range are to meet the following CVN requirements

Specified Minimum Yield Strength (2)			Longitudinal CVN Joules (kgf-m, ft-lbf) at 2 mm (0.08 in.) Sub-surface Thickness mm (in.) (1, 4)				
N/mm^2	kgf/mm^2	ksi	(t ≤ 2.0)	50 < t ≤ 70 (2.0 < t ≤ 2.8)	70 < t ≤ 100 (2.8 < t ≤ 4.0)	70 < t ≤ 150(2) (4.0 < t ≤ 6.0)	150 < t ≤ 200(2) (6.0 < t ≤ 8.0)
235 (5)	24	34	27 (2.8, 20)	35 (3.6, 26)	42 (4.3, 31)	48 (4.9, 35)	54 (5.5, 40)
275	28	40	27 (2.8, 20)	35 (3.6, 26)	42 (4.3, 31)	48 (4.9, 35)	54 (5.5, 40)
355	36	51	35 (3.6, 26)	42 (4.3, 31)	48 (4.9, 35)	54 (5.5, 40)	60 (6.1, 44)
420	43	61	42 (4.3, 31)	48 (4.9, 35)	54 (5.5, 40)	60 (6.1, 44)	66 (6.7, 49)

Notes:

1. For thicknesses above 40 mm (1.6 in.) the Charpy tests are to be taken at ¼ ***t*.**
2. For plate over 100 mm (4.0 in.) thick, in addition to note 1 Charpy tests at mid *t* are to be carried out and are to achieve at least ⅔ of the required Joule value indicated in the above table for sub-surface specimens. Alternatively the mid *t* test can be carried out at 10°C (18°F) above the specified CVN test temperature to achieve the same Charpy value specified for the sub-surface specimen. Mid *t* Charpy testing may not be required in cases where it has been established by first article testing and satisfactory manufacturing production control, that adequate mid thickness Charpy values and internal quality are maintained, and the necessary supporting documents are submitted to ABS Materials department for review. However in such cases, when deemed necessary by ABS Materials department, random mid *t* Charpy sampling may be required.
3. For intermediate yield strength values, the CVN values are based upon the Yield MPa/10 up to 50 mm (2.0 in.) and then incremented by the same scale for thickness increase.
4. For thickness above 200 mm (8.0 in.), the same CVN criteria for 150 mm to 200 mm (6.0 in. to 8.0 in.) applies to ¼ *t* and mid *t* , see Note 2. However, the criticality and component detail for each application is to be assessed and alternative criteria may be accepted or requested.
5. Steel for appurtenant or secondary structure fabricated to recognized Standards, is to be verified by, or tested to the satisfaction of the ABS Surveyor, and may be used in ABS Grade A applications without additional CVN test provided:
   i. Service temperature is -10°C (14°F) or above
   ii. Max thickness is 12.5 mm (0.5 in.) for plate, and 19 mm (0.75 in.) for sections
   iii. The structure does not contribute to the hull watertight integrity or leg structural

5.7.3 CVN Temperatures

The CVN requirements are to be obtained when tested at the following temperatures:

Secondary application structure:	service temperature
Primary application structure:	10°C (18°F) below service temperature
Special application structure:	30°C (54°F) below service temperature

5.7.4 Extra High Strength Steels

Steels in the 460 to 960 N/mm^2 (47 to 98 kgf/mm^2, 67 to 139 ksi) yield strength range are to meet the following CVN requirements at the following test temperatures.

Specified Minimum Yield Strength [3, 5]			Longitudinal CVN Joules (kgf-m, ft-lbf) at 2 mm (0.08 in.) Sub-surface Thickness mm (in.) [1, 4]	
N/mm^2	kgf/mm^2	ksi	$t \leq 100$ ($t \leq 4.0$)	$100 < t \leq 200$ [2] ($4.0 < t \leq 8.0$)
460	47	67	46 (4.7, 34)	46 (4.7, 34)
500	51	73	50 (5.1, 37)	50 (5.1, 37)
550	56	80	55 (5.6, 41)	55 (5.6, 41)
620	63	90	62 (6.3, 46)	62 (6.3, 46)
690		100	69 (7.0, 51)	69 (7.0, 51)
890	91	129	69 (7.0, 51)	69 (7.0, 51)
960	98	139	69 (7.0, 51)	69 (7.0, 51)

Notes:

1. For thicknesses above 40 mm (1.6 in.) the Charpy tests are to be taken at ¼ ***t***.
2. For plate over 100 mm (4.0 in.) thick, in addition to note 1 Charpy tests are to be carried out at mid *t* and are to achieve at least ⅔ of the required Joule value indicated in the above table for sub-surface specimens. Alternatively the mid *t* test can be carried out at 10°C above the specified CVN test temperature to achieve the same Charpy value specified for the sub-surface specimen.
3. For intermediate yield strength values, the CVN values are based upon the Yield Mpa/10.
4. For thickness above 200 mm (8.0 in.), the same CVN criteria for 100 mm to 200 mm (4.0 in. to 8.0 in.) applies to ¼ *t* and mid *t*, see Note 2. However, the criticality and component detail for each application is to be assessed and alternative criteria may be accepted or requested.

Application (per 3A-1-4/5.1, 3A-1-4/5.3 and 3A-1-4/5.5) and Test Temperature

Service Temperature	Secondary	Primary	Special
0°C (32°F)	–10°C (14°F)	-20°C (-4°F)	-30°C (-22°F)
-10°C (14°F)	–20°C (–4°F)	-30°C (-22°F)	-40°C (-40°F)
-20°C (-4°F)	–30°C (–22°F)	-40°C (-40°F)	-50°C (-58°F)
-30°C (-22°F)	–40°C (–40°F)	-50°C (-58°F)	-60°C (-75°F)
-40°C (-40°F)	–50°C (–58°F)	-60°C (-75°F)	-70°C (-94°F)
-50°C (-58°F)	–60°C (–75°F)	-70°C (-94°F)	-80°C (-112°F)

Note:
For service temperatures lower than –40°C (–40°F) consideration can be given to alternative testing requirements subject to consultation with the steel mill.

5.7.5 Z Grade Steels

When tensile stresses through the thickness (Z direction) exceed approximately 50% of the minimum specified yield stress (as defined in the applicable ABS Rules), consideration is to be given to applying Z grade steel (refer to 2-1-1/17 of the ABS *Rules for Materials and Welding (Part 2)*). Alternatives to applying Z grade may be proposed provided it is demonstrated by ultrasonic testing before and after welding that no through thickness tearing has occurred, and/or the welding preparation, weld size and bead sequence is such that damaging through thickness loads induced by weld shrinkage are avoided.

5.7.6 Alternative Requirements

As an alternative to the requirements in 3A-1-4/5.7.2 and 3A-1-4/5.7.4, steels may comply with the following.

i. For transverse specimens, $^{2}/_{3}$ of energy values shown for longitudinal specimens
ii. For longitudinal specimens, lateral expansion is not to be less than 0.5 mm (0.02 in.). For transverse specimens –lateral expansion is not to be less than 0.38 mm (0.015 in.).
iii. Nil-ductility temperature (NDT), as determined by drop weight tests, is to be 5°C (9°F) below the temperature specified in 3A-1-4/5.7.3.
iv. Compliance with 3A-1-4/Table 2 for ABS extra high strength steels.

5.7.7 Additional Requirements

It is to be noted that Coastal Authorities may have specific toughness requirements that exceed the minimum requirements of the ABS Rules. If such requirements exist, reference to the additional requirements is to be made in order to establish the required testing criteria.

TABLE 1
Material Section Requirements for ABS Ordinary and Highter Strength Steels

Numbers in table are maximum thicknesses in mm (in.)

Blank areas indicate no application

Grade	Service Temperature °C(°F)																	
	Secondary Applications						Primary Applications						Special Applications					
	0 (32)	**-10 (14)**	**-20 (-4)**	**-30 (-22)**	**-40* (-40)***	**-50* (-58)***	**0 (32)**	**-10 (14)**	**-20 (-4)**	**-30 (-22)**	**-40* (-40)***	**-50* (-58)***	**0 (32)**	**-10 (14)**	**-20 (-4)**	**-30 (-22)**	**-40* (-40)***	**-50* (-58)***
A	100 (4.00)	19 (0.75)	12.5 (0.50)	—	—	—	19 (0.75)	12.5 (0.50)	—	—	—	—	—	—	—	—	—	—
B	100 (4.00)	25 (1.00)	19 (0.75)	12.5 (0.50)	—	—	25 (1.00)	19 (0.75)	12.5 (0.50)	—	—	—	16 (0.63)	—	—	—	—	—
D	100 (4.00)	35 (1.375)	35 (1.375)	22.5 (0.89)	12.5 (0.50)	—	35 (1.375)	35 (1.375)	22.5 (0.89)	12.5 (0.50)	—	—	22.5 (0.89)	16 (0.63)	—	—	—	—
DN	100 (4.00)	100 (4.00)	100 (4.00)	27.5 (1.08)	22.5 (0.89)	16 (0.63)	100 (4.00)	100 (4.00)	27.5 (1.08)	22.5 (0.89)	16 (0.63)	—	27.5 (1.08)	22.5 (0.89)	16 (0.63)	—	—	—
E	100 (4.00)	100 (4.00)	100 (4.00)	100 (4.00)	100 (4.00)	27.5 (1.08)	100 (4.00)	100 (4.00)	100 (4.00)	100 (4.00)	27.5 (1.08)	16 (0.63)	100 (4.00)	100 (4.00)	27.5 (1.08)	16 (0.63)	12.5 (0.50)	—
AH	100 (4.00)	25 (1.00)	19 (0.75)	12.5 (0.50)	—	—	19 (0.75)	19 (0.75)	12.5 (0.50)	—	—	—	19 (0.75)	—	—	—	—	—
DH	100 (4.00)	100 (4.00)	100 (4.00)	19 (0.75)	12.5 (0.50)	—	100 (4.00)	100 (4.00)	19 (0.75)	12.5 (0.50)	—	—	19 (0.75)	16 (0.63)	—	—	—	—
DHN	100 (4.00)	100 (4.00)	100 (4.00)	27.5 (1.08)	22.5 (0.89)	16 (0.63)	100 (4.00)	100 (4.00)	27.5 (1.08)	22.5 (0.89)	16 (0.63)	—	27.5 (1.08)	22.5 (0.89)	16 (0.63)	—	—	—
EH	100 (4.00)	100 (4.00)	100 (4.00)	100 (4.00)	100 (4.00)	27.5 (1.08)	100 (4.00)	100 (4.00)	100 (4.00)	100 (4.00)	27.5 (1.08)	16 (0.63)	100 (4.00)	100 (4.00)	27.5 (1.08)	16 (0.63)	12.5 (0.50)	—
FH	100 (4.00)	100 (4.00)	100 (4.00)	100 (4.00)	100 (4.00)	100 (4.00)	100 (4.00)	100 (4.00)	100 (4.00)	100 (4.00)	100 (4.00)	27.5 (1.08)	100 (4.00)	100 (4.00)	100 (4.00)	100 (4.00)	27.5 (1.08)	16 (0.63)

Notes:

Material selection/testing proposal is to be submitted to ABS Materials Dept. for review, in case:

- Steels with thicknesses above maximum indicated in the table are selected
- Design service temperature is lower than -50°C (-58°F)

TABLE 2

Material Selection for ABS Extra High Strength Steel Grades (1)

Service Temperature °C (°F)	*Secondary **	*Primary*	*Special*
0 (32)	AQ43 to AQ70	DQ43 to DQ70	EQ43 to EQ70
-10 (14)	EQ43 to EQ70	EQ43 to EQ70	EQ43 to EQ70
-20 (-4)	EQ43 to EQ70	EQ43 to EQ70	EQ43 to EQ70
-30 (-22)	EQ43 to EQ70	EQ43 to EQ70	EQ43 to EQ70
-40 (-40)	FQ43 to FQ70	FQ43 to FQ70	FQ43 to FQ70
-50 (-58)	FQ43 to FQ70	FQ43 to FQ70	___
* For Secondary members, toughness criteria may be relaxed.			

Note:

1. Selection of grades 91 and 98 will be specially considered depending on the application and weldability.

Chapter 2 Hull Structures and Arrangements

Section 3 Self-Elevating Units

9 Hull Interface Structure with Legs

Jackcases and associated supporting bracing system are to have adequate strength to properly transmit the loads between the legs and the hull using the allowable stresses defined in 3A-2-1/3.

The factor of safety for combined loadings as given in 3A-2-1/3.3 is to be used when considering structural aspects of preload condition.

In no case, are the loads imposed at the holding mechanism of the jacking system or the fixation system to exceed the holding capacity defined by the manufacturer of the device for all modes of operation. Reference is made to Section 6-1-9.

For the purpose of providing loading guidance in the operations manual required in Section 1B-2-3 of the ABS *Rules for Conditions of Classification - Offshore Units (Part 1B)*, friction losses directly related to the leg interfaces are to be considered when establishing the loads imposed on a jacking system during lifting operations. Values for friction losses such as those at the leg guides and at the rack and pinion mesh are to be provided by the relevant designer. Alternatively, for rack and pinion systems, the minimum total friction allowance for the leg interface may be taken as not less than 8% of the torque available on the climbing pinion shaft.

19 Fluid Power Cylinders

19.1 General

Fluid power cylinders subject to pressures or temperatures greater than those indicated below are to be designed, constructed and tested in accordance with a recognized standard for fluid power cylinders.

- *Hydraulic fluid – flammable:* 7 bar (7.1 kgf/cm², 101.5 psi) or 60°C (140°F)
- *Hydraulic fluid – non-flammable:* 16 bar (16.3 kgf/cm², 232 psi) or 200°C (392°F)
- Air: 16 bar (16.3 kgf/cm², 232 psi) or 200°C (392°F)

Acceptance is based on the manufacturer's certification of compliance and on verification of permanent identification on each cylinder bearing the manufacturer's name or trademark, standard of compliance and design pressure and temperature.

19.3 Non-compliance with a Recognized Standard

Cylinders subject to pressures or temperatures higher than those indicated above which are not constructed to a recognized standard may be accepted based on the following:

i. Regardless of diameter, the design of the cylinder is to be shown to comply with one of the following:
   - A recognized pressure vessel code,
   - Section 4-4-1 of the *Marine Vessel Rules*. For instance, the cylinder is to have a wall thickness not less than that given by equation 2 of 4-4-1-A1/3.1 the *Marine Vessel Rules*, and the cylinder ends are to meet the requirements of flat heads in 4-4-1-A1/5.7 the *Marine Vessel Rules*, or
   - Verification through burst tests. Steel cylinders (other than cast steel) are to withstand not less than 4 times the design pressure, while cast steel, cast iron and nodular iron cylinders are to withstand not less than 5 times the maximum allowable working pressure.

   Documentation in this regard is to be submitted for review. See 7A-1-3/21 for survey requirements.
ii. Each individual unit is to be hydrostatically tested to 1.5 times the design pressure (2 times, for cast iron and nodular iron cylinders) by the manufacturer. A test certificate is to be submitted.
iii. Each cylinder is to be affixed with a permanent nameplate or marking bearing the manufacturer's name or trademark and the design pressure and temperature.

19.5 Materials

i. The materials of the cylinders are to comply with the requirements of the standard or code to which they are designed and constructed. Where the design is verified though burst tests, the materials of the cylinder are to comply with 4-4-1/3 of the *Marine Vessel Rules* or other acceptable standards.
ii. Ordinary cast iron having an elongation of less than 12% is not to be used for cylinders expected to be subjected to shock loading.
iii. Copies of certified mill test reports are to be made available to the Surveyor upon request.

19.7 Rudder Actuators

Rudder actuators are to be in accordance with the requirements of 4-3-4/7.3.1 of the *Marine Vessel Rules*.

19.9 Cylinders Below Pressures or Temperatures Indicated in 4-2-2/19.1

Cylinders subject to pressures and temperatures at or below those indicated in 4-2-2/19.1 are acceptable in accordance manufacturer's rating and verification of suitability for the intended service.

19.11 Exemptions

Fluid power cylinders that do not form part of the unit's piping systems covered in Part 4, Chapter 2 and Part 6, Chapter 1 are exempt from the requirements of 4-2-2/19. However, those fluid power cylinders which are integrated into piping systems associated with optional classification notations are to comply with the requirements of 4-2-2/19 and the applicable requirements specified in the applicable ABS Rules and Guides.

3 Hydraulic Systems

3.1 General

The arrangements for Class I and II hydraulic piping systems are to be in accordance with the requirements of this section, except that hydraulic systems which form part of an independent device or equipment not covered by these Rules and which does not form part of the unit's piping system (such as a crane) are not covered by this Section, unless it is relevant to an optional notation or certification requested for the unit. Plans showing clearly the arrangements and details are to be submitted for review. The requirements for fuel oil tanks contained in 4-2-5/2.1.2 and 4-2-5/2.3 are also applicable for tanks containing hydraulic fluid.

3.3 Valves

3.3.1 General

Valves are to comply with the requirements of 4-2-2/9 and 4-2-2/17.

3.3.2 Relief Valves

Relief valves are to be provided for the protection of the hydraulic system. Each relief valve is to be capable of relieving not less than full pump flow with a maximum pressure rise of not more than 10% of the relief valve setting.

3.5 Piping

Piping is to meet the requirements of 4-2-1/9 and 4-2-2/5, except that mill tests need not be witnessed by the Surveyor. In such cases, mill certificates are to be provided.

3.7 Pipe Fittings

Fittings and flanges are to meet the requirements of 4-2-2/11 and 4-2-2/15, except as follows.

3.7.1 Non-standard Fittings

Fittings which are not constructed to a recognized standard are subject to ABS technical assessment and approval. Plans showing details of construction, material and design calculations or test results are to be submitted for review.

3.7.2 Split Flanges

Split flanges are not to be used in steering gear systems and certified thruster systems for propulsion or station keeping service. The use of split flanges for all other applications will be specially considered.

3.7.3 Straight Thread O Ring Connections

Straight thread O ring type connections are acceptable for connections to equipment such as pumps, valves, cylinders, accumulators, gauges and hoses. Such connections are not to be used for joining sections of pipe.

3.7.4 Taper Thread Connections

Taper thread connections up to and including 89 mm O.D. (3 in. N.P.S.) are acceptable without limitation for connections to equipment such as pumps, valves, cylinders, accumulators, gauges and hoses.

Such connections are not to be used for joining sections of pipe, except where permitted by 4-2-2/11.1.

3.9 Flexible Hoses

Hose assemblies are to be in accordance with 4-2-1/11.29.

3.11 *Accumulators*

Accumulators are to meet the requirements of 4-6-7/3 of the *Marine Vessel Rules*. Each accumulator which may be isolated is to be protected by suitable relief valves. Where a gas charging system is used, a relief valve is to be provided on the gas side of the accumulator.

3.13 *Fluid Power Cylinders*

Fluid power cylinders are to meet the requirements of 4-2-2/19.

3.15 Segregation of High-Pressure Hydraulic Units

Hydraulic units with maximum working pressures above 15.5 bar (15.8 kgf/cm^2, 225 psi) installed within machinery spaces are to be placed in separate room or rooms or shielded as necessary to prevent any oil or oil mist that may escape under pressure from coming into contact with surfaces with temperatures in excess of 220°C (428°F), electrical equipment or other sources of ignition. For the purposes of this requirement, a hydraulic unit includes the power pack and all components of the hydraulic piping system.

Chapter 3 Electrical Installations

Section 2 Electrical Systems

15.5.4 Jacking System

A voice communication system is to be provided between the central jacking control station and a location at each leg in self-elevating units.

Section 4 Machinery and Equipment

5 Computer-Based System (CBS)

A programmable electronic device, or interoperable set of programmable electronic devices, is organized to achieve one or more specified purposes such as collection, processing, maintenance, use, sharing, dissemination, or disposition of information. CBSs onboard include IT and OT systems. A CBS may be a combination of subsystems connected via network. Onboard CBSs may be connected directly or via public means of communications (e.g. Internet) to ashore CBSs, other vessels' CBSs and/or other facilities.

CBSs are to meet the requirements of Section 4-9-3 of the *Marine Vessel Rules*, even when the unit will not be assigned with ***ACC*** or ***ACCU*** notations.

CBSs associated with remote propulsion control, are also to comply with 4-3-5/3.11.2.

19.1 Generators and Motors ≥ 100 kW (135 hp) intended for Essential Services

Factory testing schedule required for generators and motors of 100 kW (135 hp) and over intended for essential services are indicated with an "X" mark in 6-1-7/19.23 TABLE 2. Requirements for compliance are further referenced in 6-1-7/5.1 through 6-1-7/5.19, 6-1-7/19.23 TABLE 3 and 6-1-7/19.23 TABLE 4.

Construction and assembly of rotating machines are to be verified in compliance with 6-1-7/5.11 and their nameplates are to indicate at least the information as listed in 6-1-7/19.23 TABLE 5.

All generators and motors ≥ 100 kW (135 hp) intended for essential services are to be examined and tested in presence of and to the satisfaction of the Surveyor. Examination and testing of other generators and motors may be carried out without a Surveyor's presence, but the manufacturer's test certificate is to be available to the Surveyor attending construction of the unit at shipyard.

1 Objective

1.1 Goals

The jacking and associated systems covered in this section are to be designed, constructed, operated, and maintained to:

Goal No.	**Goal**
SAFE 1.1 AUTO 3	minimize danger to persons on board, the unit, and surrounding equipment/ installations from hazards associated with machinery and systems. have an alternative means to enable safe operation in the event of an emergency or failure of remote control.
AUTO 4	provide the equivalent degree of safety and operability from a remote location as those provided by local controls.
AUTO 5	provide a safety system that shall automatically lead machinery controlled to a fail-safe state in response to a fault which may endanger the safety of persons on board, machinery/equipment, or the environment.

Materials are to be suitable for the intended application in accordance with the following goals and support the Tier 1 goals as listed above.

Goal No.	**Goal**
MAT 1	The selected materials' physical, mechanical and chemical properties are to meet the design requirements appropriate for the application, operating conditions and environment.
MAT 2	The manufacturing process is to be capable of producing products with sufficient quality and consistent physical, mechanical and chemical properties to meet the design assumptions and to prevent premature failure.

The goals in the cross-referenced Rules/Regulations are also to be met.

1.2 Functional Requirements

In order to achieve the above stated goals, the design, construction, installation and maintenance of the jacking and associated systems are to be in accordance with the following functional requirements:

Functional Requirement No.	Functional Requirements
Safety of Personnel (SAFE)	
SAFE-FR1	The jacking system is to provide sufficient redundancy to prevent uncontrolled descent upon failure of any one component.
SAFE-FR2 (MGMT)	Gear system alignment are to be installed and maintained within design limits throughout equipment life to enable proper functioning of the jacking system.
SAFE-FR3	Brakes are to perform fail-safe engagement and secure holding for the specific conditions necessary to achieve the holding capacity.
SAFE-FR4	The flexible shock pads are to endure severe storm loads, and withstand marine and working environment degradation.
Automation (AUTO)	
AUTO-FR1	Critical and essential items are to be alarmed and displayed at a central jacking control station to protect against failure through preventive measures
AUTO-FR2	Provide independent means of shutdown for jacking system operation in an emergency at the central jacking control station and at each jack house.
AUTO-FR3	Provide an override option to prevent the jacking system from being locked out when the sensing device for fixation system disengagement fails.
AUTO-FR4	Provide means to identify and rectify discrepancies in rack phase alignment where necessary to avoid potential collapse or failure of the structure being supported.
AUTO-FR5	Provide remote control at a centralized location for coordinated operations of the jacking and holding except permanent fixation and redundant controls in case of failure of the remote control.
Materials (MAT)	
MAT-FR1	The material and components for jacking system, holding mechanism, and associated systems are to withstand the maximum working stresses without any deformation or fatigue failure.
MAT-FR2	The material elongation for the load bearing / torque transmitting components is to be sufficiently high so that it can withstand accidental shock or impact loads during service.

The Functional Requirements in the cross-referenced Rules/Regulations are also to be met.

1.3 Compliance

A unit is considered to comply with the goals and functional requirements when the applicable prescriptive requirements are complied with or when an alternative arrangement has been approved. Refer to Part 1D, Chapter 2.

2 General

Jacking systems are used to elevate and lower the hull of self-elevating units in the elevated condition and to raise and lower the legs in the afloat condition.

The hull of the unit is maintained stationary in the elevated condition by means of a holding mechanism. The same mechanism is used to maintain the legs stationary in the afloat condition.

The jacking system and holding mechanism on self-elevating units are to be designed and constructed with sufficient redundancy so that upon failure of any one component, the system will prevent an uncontrolled descent of the unit. This is to be accomplished either by continuing to jack to a safe position or holding in place. Approved procedures are to be provided to allow emergency raising or lowering of the unit after failure in case the unit is holding in an unsafe position.

Jacking systems are to be considered as machinery to provide the vertical movement of the legs as well as structural elements transmitting the loads between hull and legs, as applicable to the particular system design.

3 Definitions

The following definitions apply for the purpose of this Section.

3.1 Jacking System

A mechanical system used for raising the hull of a self-elevating unit above the surface of the sea by simultaneously applying a downward force on the movable legs of the unit. The same system is used for lowering the hull from the elevated condition in a controlled manner and for raising and lowering the legs relative to the hull in the afloat condition. The most commonly used jacking systems are the rack and pinion type and the yoke and pin type.

3.3 Holding Mechanism

A mechanism used for maintaining the hull of a self-elevating unit stationary in the elevated condition and/or maintaining the legs of the unit stationary in the afloat condition. The holding mechanism may be either the jacking system in a static position or a separate fixation system or a combination of both.

3.5 Rack and Pinion Jacking System

A jacking system using climbing pinions, most commonly driven by electric or hydraulic motors through a jacking gearbox, to engage with racks attached to the legs of the unit in order to raise or lower the hull in relation to the legs in the elevated condition or to raise or lower the legs in relation to the hull in the afloat condition.

3.7 Yoke and Pin Jacking System

A jacking system using yokes with pins, both operated by hydraulic cylinders, to engage with holes on the legs of the unit in order to raise or lower the hull in relation to the legs in the elevated condition or to raise or lower the legs in relation to the hull in the afloat condition.

3.9 Fixation System

A holding mechanism, independent from the jacking system, using a device attached to the hull to engage a counterpart device in the legs in order to establish a rigid connection between the hull and the legs of the unit.

3.11 Specified Service Temperature

Minimum atmospheric temperature identified for the unit (see 3A-1-1/25 and 3A-1-2/1) and documented in the Unit's Operations Manual as per 1B-2-3/1 of the ABS *Rules for Conditions of Classification – Offshore Units (Part 1B)*

3.13 Jacking Unit Rated Capacity

Vertical effective force delivered to the leg by the jacking system per jacking unit when raising or lowering the hull. Effective force is inclusive of all frictional effects directly related to the jacking unit including leg interfaces such as a rack and pinion mesh.

3.15 Lifting Capacity per Leg

Vertical force per leg by the combination of jacking units attached to the leg, including the leg guide friction effect.

3.17 System Integrator

The role of the system integrator is to be filled by the yard unless an alternative organization is specifically contracted for or assigned this responsibility. The system integrator is responsible for the integration of systems and products provided by suppliers into the system according to the requirements specified herein and for providing the integrated system. The system integrator may also be responsible for integration of systems in the unit.

5 Plans and Data to be Submitted

The following plans and data are to be submitted for the jacking and associated systems, as applicable:

i. A description of the jacking system, holding mechanism and associated systems
ii. Failure Modes and Effects Analysis (FMEA)
iii. Design plans showing the following arrangements and details, as applicable:
    - Jacking system, including mechanical and hydraulic components such as rack and pinion, bearings, reduction gears, brakes, hydraulic power units, hydraulic cylinders, etc.
    - Fixation system
    - Jack case (fixed or floating frame)
    - Electric system diagrams
    - Jacking motor and brake specifications and operating characteristics
    - Electric and/or hydraulic controls
    - Monitoring and alarm systems
    - Lubrication methods
    - Heating arrangements for low temperature operation
iv. Material specifications
v. Design calculations, including strength, fatigue, buckling, rigidity and critical speed (resonance) analyses, as applicable to the particular system
vi. Specified service temperature
vii. Limits of alignment/misalignment between rack and pinions
viii. Motor Information:
    - Design documentation
    - Confirmation of application to jacking service
    - Shaft design documentation (including materials) for brake arrangements subjecting shaft to normal and/or storm holding loads while brake is engaged
ix. Brake documentation:
    - Design documentation including brake static and dynamic capacities, and basis for establishing these values
    - Confirmation of application to jacking service
    - Any necessary conditions for attaining specified holding capacities
x. Specifications and documentation of computer-based control systems
xi. Technical limitations which may apply for emergency raising or lowering of the unit (such as loads, inclination, etc.)
xii. Nondestructive examination details and procedure for inspecting components along the direct load path including locations of inspection, types of inspection, and acceptance/rejection criteria. Acceptance/rejection criteria is determined by the jacking gear box designer.
xiii. List of equipment that make up the jacking system along with the details of the suppliers responsible for submitting drawings to ABS. The list is to be supported by ABS design review letter or product design assessment (PDA) for the equipment, as applicable. When unit certification is required for equipment or component per 6-1-9/Table 2, corresponding ABS survey reports are to be made available to the attending Surveyor for integration of the jacking and associated systems.

Each individual piece of equipment and/or subsystem will be issued an ABS review letter. Further, an overall system-level review letter will be issued to the system integrator upon completion of the review of the above plans and data

7 Failure Modes and Effects Analysis (FMEA)

A failure modes and effects analysis (FMEA) is to be carried out on the jacking system and holding mechanism with the purpose of demonstrating that a single failure of any component will not cause an uncontrolled descent of the unit. The FMEA methodology has to ensure that any predictable failure mode relevant to the purpose of the FMEA has been considered and is to be sufficiently detailed to cover all systems associated with the jacking and holding operations. The FMEA is to be submitted for review and is to include but not be limited to the following information:

- A description of all the systems associated with the jacking and holding operations of the unit and a functional block diagram showing their interaction with each other. Such systems include the jacking systems, the fixation systems, jack case, electrical power distribution system, hydraulic power system, control systems (including programmable systems and their physical components such as programmable logic controllers, network hubs, cards, buses, cabling, encoders, and interfaces/displays), monitoring and alarm systems, etc. and their subcomponents.
- All significant failure modes relevant to the purpose of the FMEA
- Each predictable cause associated with each failure mode
- The method of detecting that the failure has occurred
- The effect of the failure upon the rest of the system's ability to jack the unit, including time effects (i.e., if necessary time is available for manual intervention)
- An analysis of possible common failure modes

Where parts of the system are identified as non-redundant and where redundancy is not possible, these parts are to be further studied with consideration given to their reliability and mechanical protection. The results of this further study are to be submitted for review.

9 Material

The material specifications for the components of the jacking system, holding mechanism and associated systems including structural load carrying components (such as rack and jack case for rack and pinion units or jacking pins and yoke for hydraulically actuated units), torque transmitting parts (such as climbing pinion, gears, pinions, planet carriers, pins, shafts, torque supports, couplings, coupling bolts, shafts, torque flanges and brakes of rack and pinion units), fixation system components and hydraulic components (such as hydraulic cylinders and actuators), as applicable to the particular system design, are subject to approval and are to be submitted by the designer. These specifications are to include as a minimum, chemical composition, yield strength, ultimate tensile strength, percent elongation and reduction of area, and hardness for gears and coupling teeth, and where required, impact values.

Load bearing or torque transmitting components in the direct load path are to be constructed of steel, with elongation and reduction in area properties in accordance with Chapter 3 of the ABS *Rules for Materials and Welding (Part 2)*. Subject to ABS technical assessment and approval, high strength case hardened gears made to recognized standards may have a minimum elongation value of 8%. Other acceptable ductile materials can be applied provided they have a minimum elongation of not less than 12%. Other materials suitable for the intended purpose are subject to ABS technical assessment and approval.

Note:

Materials for bushing, shim plates and other components under compressive loads only need not be ductile.

Materials for the load-bearing components of the fixation system in the direct load path are to comply with 3A-1-4/5.5 and 3A-1-4/5.7, as applicable. However for fixation systems that are not of welded construction, or are constructed from forgings or castings, the minimum required Charpy values for steel load-bearing components are to be in accordance with 6-1-9/TABLE 1.

Material manufacturers are to be ABS approved in accordance with Chapters 1 to 3 of the ABS *Rules for Materials and Welding (Part 2).* The approval scope is to include all heat treatment facilities used by the manufacturer in the production of jacking components. For initial new production processes of the following direct load path components: jacking pins, pinions, planet carriers, gears, shafts, torque plates, torque couplings and torque transmitting jack casing, each manufacturer is to submit a production process plan to ABS prior to commencing production. This can be done in the format of a manufacturing inspection procedure (MIP), and/or an inspection and testing procedure (ITP). The manufacturers are to demonstrate to the satisfaction of the attending Surveyor, by first article testing, that actual products meet the mechanical properties required by the design. This is to be done by sacrificing a sample product or extracting a sample from an actual product.

To establish correct tempering temperatures, heat treatment sensitivity studies are to be carried out to demonstrate the tempering range where tensile, ductility and toughness are optimized. Data from the sensitivity studies is to be submitted to ABS. Alternatively, supporting data of existing heat treatment processes with satisfactory mechanical test results can be submitted in lieu of sensitivity studies.

Chemistry additions, forging and casting processes, and heat treatment practices are to be controlled, to avoid detrimental microstructures and precipitates that may degrade the mechanical properties of the material.

9.1 Toughness

The following toughness requirements refer to the core material after all thermal treatments.

For rack and pinion units, steel for the rack and rack attachments and the frame which attaches to the hull structure is to meet the toughness requirements for primary application (see 3A-1-4/5.3.2) at the specified service temperature in accordance with 3A-1-4/5.5 and 3A-1-4/5.7, as applicable to the steel grade. Steel for the frame which will be used in cases of floating jacking systems is to meet the toughness criteria for secondary application (see 3A-1-4/5.3.3) at the specified service temperature.

For systems actuated by hydraulic cylinders, steel for jacking pins and yoke is to meet the toughness criteria for primary application (see 3A-1-4/5.3.2) at the specified service temperature in accordance with 3A-1-4/5.5 and 3A-1-4/5.7, as applicable to the steel grade.

Steel for torque transmitting parts for rack and pinion units is to meet the Charpy V Notch (CVN) impact requirements in 6-1-9/TABLE 1. Charpy tests on forgings can be taken in the transverse or longitudinal direction. The longitudinal and transverse forging directions are to be determined by the forge and recorded in supporting documentation.

Materials other than steel are to exhibit fracture toughness which is satisfactory for the intended application, as evidenced by previous satisfactory service experience or appropriate toughness tests.

TABLE 1
Charpy V-Notch (CVN) Impact Requirements for Steel Materials

Application	*Charpy V-Notch (CVN) Minimum Average Values at Specified Service Temperature (SST)*								
	Forgings Longitudinal CVN Test			*Forgings Tangential CVN Test*			*Castings*		
	J	*kgf-m*	*ft-lbf*	*J*	*kgf-m*	*ft-lbf*	*J*	*kgf-m*	*ft-lbf*
Climbing Pinion and Planetary Carriers	27	2.8	20	20	2.0	15	20	2.0	15
Low Speed Gears and Pinions (1)	20	2.0	15	15	1.5	11	15	1.5	11
Fixation System(3)	34	3.5	25	24	2.4	17	24	2.4	17
Other (2)	SST of -20° C (-4° F) and above Not Required								
	SST below -20° C (-4° F) Subject to ABS technical assessment and approval								

Notes:

1 As defined in 6-1-9/11, mesh rate MR < 100 Teeth / Minute

2 Torque transmitting / load bearing components in the load path (other than climbing pinion, planetary carriers and low speed gears and pinions), such as high-speed pinions and gears, planetary ring gears, torque supports, shafts, pins, couplings and coupling bolts.

3 Forging requirement applies for un-welded plate.

11 Strength Analysis

11.1 Conditions to be Analyzed

Strength calculations of the jacking system and holding mechanism are to be submitted in accordance with 6-1-9/5. Strength calculations are to consider at least the maximum loads of the following loading conditions, as applicable to the unit:

- Normal raising of hull
- Normal holding of hull
- Normal lowering of hull
- Pre-load raising
- Pre-load holding
- Pre-load lowering
- Normal raising of legs
- Normal holding of legs
- Normal lowering of legs
- Severe storm holding (elevated or afloat)

Maximum rated loads associated with the normal jacking, pre-load jacking and normal holding conditions may be considered as static loadings only, where the static loads include operational gravity loadings and weight of the unit, with the unit afloat or resting on the sea bed in calm water. Maximum rated loads associated with severe storm conditions (elevated or afloat) and pre-load holding condition are to be considered as combined loadings, where the applicable static loads are combined with relevant environmental loadings, including acceleration and heeling forces.

When establishing the loads imposed on a jacking system during lifting operations for the purpose of providing loading guidance in the operations manual required in Section 1B-2-3 of the ABS *Rules for Conditions of Classification Offshore Units (Part 1B)*, friction losses are to be considered as defined in 3-2-3/9.

11.3 Strength

11.3.1 Individual Stresses

For the purpose of strength calculation of the jacking system and for designing mechanical components (including pins), the stress is not to exceed $F_y/F.S.$ where:

F_y = specified minimum yield point or yield strength, as defined in Chapter 1 of the ABS *Rules for Materials and Welding (Part 2)*

$F.S.$ = factor of safety

For static loadings, as defined above:

= 1.67 for axial or bending stress

= 2.50 for shear stress

For combined loadings, as defined above:

= 1.25 for axial or bending

= stress 1.88 for shear stress

except that gear reducers are to comply with a recognized standard such as American Gear Manufacturers Association (AGMA) standards or ISO. Gear rating calculations and justification of the applied gear design coefficients in accordance with the applicable design standard are to be submitted to ABS for review.

Alternative design methods for low speed gears with a mesh rate MR less than 100 teeth/minute (where MR = RPM x Number of teeth) are subject to ABS technical assessment and approval based on the submission of adequate evidence to validate the design method, such as first principles calculations, experimental data and satisfactory operation experience for the intended application. The alternative design methods are to take into account all the various degradation factors, such as dynamic factor, non-uniform load distribution or misalignment.

11.3.2 Von Mises Approach

When recognized standards are not applicable, structural and mechanical components may be designed according to the von Mises equivalent stress criterion. Except for components under compressive loads only, the equivalent stress is not to exceed $F_y/F.S.$ where:

F_y as defined in 6-1-9/11.3.1

$F.S.$ = 1.43 for static loading, as defined in 6-1-9/11.3.1 for

= 1.11 combined loading, as defined in 6-1-9/11.3.1

11.3.3 Fixation System

The scantlings of the load-bearing components of the fixation system in the direct load path are to be determined on the basis of the allowable stresses specified in 6-1-9/11.3.1 or 6-1-9/11.3.2.

11.5 Buckling

As applicable to the design, the buckling strength of structures is to be verified according to the latest version of the ABS *Requirements for Buckling and Ultimate Strength Assessment for Offshore Structures*, or other recognized standard acceptable to the ABS.

11.7 Fatigue

Fatigue damage of jacking system components due to cyclic loading is to be considered. A fatigue analysis is to be performed using an appropriate loading spectrum. The fatigue analysis is to be based on recognized fatigue assessment methodologies such as those shown in the latest editions of AGMA and ISO gear standards or the

Miner's Rule for cumulative fatigue. For gears, both tooth surface contact and tooth root bending fatigue strength are to be considered. The calculated fatigue life is to be at least the design life of the unit, but not less than 20 years. Safety factors against maximum fatigue life in hours or cycles are to be as follows:

1. Tooth root bending: *F.S.* = 1.5 for cumulative fatigue due to all lifting and lowering operations and all other applicable cyclic loads
2. Tooth surface contact: *F.S.* = 1.0 for cumulative fatigue due to all lifting and lowering operations and all other applicable cyclic loads

In the calculation of the tooth surface contact fatigue, the magnitude/effect of non-uniform face load distribution is to be considered. Inspectable low speed, through hardened pinions and gears may not need to comply with the above safety factor for tooth surface contact fatigue, subject to past satisfactory experience with material and design for this purpose.

Jacking system design may be accepted based on full life-cycle fatigue load test results in lieu of theoretical fatigue calculations. Acceptability of test results is to be governed by the type and the extent of the testing. When testing for fatigue, the jacking system or parts are to be subject to all the applicable maximum cyclic loading conditions and each applicable load level is to be multiplied with relevant safety factors. The safety factors applied in case of full life-cycle fatigue load test are subjected to ABS technical assessment and approval.

Note:

Full-life cycle fatigue load test does not exclude the required mandatory prototype test.

Where applicable, critical speed (resonance) analysis of rotating components is to be submitted to demonstrate that there are no harmful vibrations at operating speeds. Test results in lieu of theoretical analysis may be considered.

11.9 Alignment

For rack and pinion systems, the alignment between the rack and pinion is to be maintained within specified limits throughout the life of the rig. Documentation in this regard is to be submitted to the ABS.

13 Mechanical Components

In addition to the strength requirements for mechanical components in accordance with 6-1-9/11, the following requirements are to be complied with:

Commentary:

Recommend that a greasing system be integrated into the design to minimize wear, pollution, and personnel hazards.

End of Commentary

13.1 Bearings

Bearings are to be designed for the operational static and dynamic loads in accordance with applicable recognized standards such as the latest editions of ISO 76 and ISO 281. Design calculations are to be submitted for bearings not covered by recognized standards. Adequate bearing lubrication is to be provided. Manufacturer’s documentation is to be submitted to confirm the suitability of the bearings for operation at the design temperature of the unit.

13.3 Brakes

Brakes are to be designed to engage automatically in the event of failure of power supply to the motor (fail-safe type). The brake holding capacity is to be at least equal to 120% of the maximum required brake torque associated with the maximum rated load applied to the climbing pinion from all loading conditions specified in 6-1-9/11. Brake static capacity is to be applied in holding conditions, and dynamic capacity (i.e., ability to stop motion) is to be applied for raising and lowering conditions.

The brake manufacturer is to submit documentation identifying the static and dynamic capacities of the brakes, the basis upon which these capacities have been established (e.g., by testing), and statement confirming that the brakes are intended for jacking gear service. The prototype tests (holding capacity tests) are to be witnessed by ABS. Dynamic capacity is to be established based on the operational speed of the motor and may reflect regenerative braking if provided.

Any conditions on attaining the stated holding capacity are to be specified by the manufacturer, and are to be included in maintenance manuals or marked on the data plate attached to the brake housing or casing. Examples include clearance range (air gap, minimum and maximum), brake run-in procedures, maximum ambient or operating temperature, minimum number of springs to be maintained in the brake, or maximum number of stops in a given time period.

13.5 Flexible Shock Pads

Jack case shock pads are to be designed for the maximum severe storm loads and suitable for operation at the design temperature of the unit. Shock pads are to be suitably protected against adverse effects of the marine and working environment which may lead to degradation. Manufacturer's technical specification or similar documentation is to be submitted to verify the suitability of the shock pads for the intended service.

15 Electrical Power System

15.1 Electric Motor Drive

Jacking gear motor installations are to be in accordance with Part 4, Chapter 3, Section 6-1-7, 6-1-9/TABLE 2, and the requirements below, Design documentation is to be submitted for all motors, with particular attention paid to brake arrangements where the motor shaft is subject to the normal and/or storm holding loads. Where the shaft is subject to such loads, design review and material testing of the motor shaft are to be carried out in accordance with 6-1-9/9 under the applicable loads.

The capacity of the electric motor is to be sufficient for lifting requirements such as the following:

- Lifting the platform with uneven load (but within approved tolerances) for a specific duration;
- Lifting in preload, if specified, with a specific duration.

The friction between legs and guides, as well as the efficiency of the gear transmissions, is to be considered. See 6-1-9/11.1.

Group motor installations are permitted as follows:

- On each leg, two or more motors of any power may be connected to a single branch circuit.
- The branch circuit is to be provided with short circuit protection set at not greater than ten times the sum of the full load currents of the motors.

A visual and audible alarm is to be provided at the jacking control station to indicate an overload condition in any of the jacking motors.

The motor manufacturer is to confirm that motors are intended for jacking gear service and are rated for operation over the required range of input voltage, current, frequency, and other parameters as applicable. Limitations on the motor such as maximum number of starts per hour or the minimum time between starts of the electric motors are also to be specified.

17 Hydraulic System

The hydraulic system for jacking units and holding mechanisms is to be in accordance with 4-2-6/3. Design of hydraulic cylinders and actuators, including materials, is to be in accordance with 4-2-2/19. Hydraulic cylinders are to be considered both as pressure containing and load bearing units.

Sufficient redundancy of the hydraulic power unit or units servicing the jacking systems is to be provided to maintain continuous jacking operation in the event of a single failure in the hydraulic power system.

17.1 Hydraulic Motor Drive

Hydraulically driven motors used for elevating and lowering the unit are to be designed based on applicable pressure vessel and piping standards for pressure retaining components, allowable stress for torque components, and recognized standards for seals. As an alternative to design review, mass produced motors may be accepted on the basis of specification review and a prototype test to 150% of the rated load, subject to agreement on design standards and manufacturing process.

Where an integral brake is not provided, the arrangement is subject to review and testing of the motor shaft if it is subject to normal and storm holding loads, as indicated in 6-1-9/15.1 for electric motors.

19 Control, Monitoring and Alarm System

Operation of the jacking system and holding mechanism is to be possible from a central jacking control station, except that the operation of a fixation system is to be from a local control station in visual proximity to the system at each leg chord. The central jacking control station is to be provided with the following alarms and indications, as applicable to the particular system design:

i. Audible and visual alarms for:
  - Motor overload, over temperature or overvoltage for each motor
  - Unit out-of-level (elevated condition)
  - Significant differences in the currents or torque in the motors on one rack
  - Rack phase differential, where applicable to the design
  - Brake fault, overload or overheating
  - PLC failure

ii. Indication of:
  - Availability of power
  - Current or torque in each motor (during raising and lowering operations)
  - Brake release status
  - Hydraulic pressure
  - Air pressure
  - Pin position
  - Position of yoke
  - Inclination of the unit, in two horizontal, perpendicular axes (elevated condition)
  - Re-Torque mode
  - Motor and brake fault override for each leg
  - Motor heater power for each leg

Upon failure of the jacking system controls in the central control station, emergency controls to operate the jacking system are to be available.

An emergency stop is to be provided at the central jacking control station and at each jack house. Emergency stop circuits are to be independent from the jacking control circuits. An override of the interlock between jacking operation and fixation system engagement is to be provided to prevent the jacking system from being locked-out in the case of a failure of the sensing device for fixation system disengagement. A communication system as defined in 4-3-2/15.5.4 is to be provided.

Procedures and/or arrangements for confirming engagement and full disengagement status of fixation system are to be verified by attending Surveyor. The procedures are to be incorporated into the Operating Manual as specified in 1B-2-4/1.17.

Arrangements are to be provided for detecting and correcting rack phase differential, where applicable to the design.

19.1 Programmable Electronic System (PES)

Where the jacking system uses Programmable Electronic Systems as defined in 4-3-4/5 for control and/or monitoring of jacking operations, such systems are to comply with Section 4-9-3 of the *Marine Vessel Rules*. Category I or II is to be assigned based on the functionality and criticality of the Programmable Electronic Systems. If a Programmable Electronic Systems is only used for monitoring and indication, Category I can be assigned. If control logic operates part or all of the functions of the system, Category II may be assigned depending on the FMEA findings.

Programmable Electronic jacking control Systems are not considered “integrated” systems for the purposes of applying 4-9-3/5.3 of the *Marine Vessel Rules*.

Basic and application software for control systems are to reboot into a proven safe jacking system holding mode.

21 Low Temperature Operation

Jacking systems, holding mechanisms and associated systems intended for operation at a specified service temperature below -20°C (-4°F) are subject to ABS technical assessment and approval.

23 Jacking Systems of Novel Design

Jacking systems other than rack and pinion type or yoke and pin type are subject to ABS technical assessment and approval. Compliance with this section is required, as applicable. The suitability of the novel features is subject to ABS technical assessment and approval on the basis of first principles, applicable recognized standards and experimental test results, depending on the particular characteristics of the jacking system and type of unit.

25 Survey and Certification

All jacking or other elevating systems for Self-Elevating Units are required to be certified by the attending Surveyor before installation and onboard testing.

Electric motors intended for jacking systems are to be certified as per 6-1-7/19.1 and/or 6-1-9/15.1.

Hydraulic motors are to be functionally tested as per manufacturer's test procedures and certified at the manufacturer facility as per 6-1-9/17.1.

Gear box units are to be functionally tested as per manufacturer's test procedures and certified at the manufacturer facility. The components of the gear box are to be tested as per requirements in 6-1-9/Table 2. The accuracy of the meshing is to be verified by the attending surveyor.

25.1 Inspection and Material Testing

All jacking systems, holding mechanisms and associated systems are to be constructed and installed to the satisfaction of the Surveyor in accordance with approved plans.

Welded construction is to be in compliance with the applicable requirements of Section 3-2-6, 7-1-2/9 and 7-1-2/11 of these Rules and Chapter 4 of the ABS *Rules for Materials and Welding (Part 2)*. Material tests for the components of the jacking systems, holding mechanisms and associated systems are to be carried out in accordance with 6-1-9/9 and Chapters 1 to 3 of the above referenced Part 2. All material testing as indicated in 6-1-9/TABLE 1 is to be witnessed by the attending Surveyor.

Gears of the climbing pinion gear train are to be examined at the plant of the manufacturer by an approved crack detection procedure and such examination is to be witnessed by the Surveyor. For direct load path components, the locations of inspection, types of inspection and acceptance/rejection criteria are to be clearly indicated in the documentation. Surface and volumetric inspection is to be performed to a recognized Standard appropriate to the process of manufacture, such as ASTM A275, A903, A388 or A609. Acceptance criteria is to be submitted by the designer for approval. In determining the inspection details and acceptance criteria consideration is to be given to:

i. The material type and grade (influence on crack sensitivity)
ii. The mill process (steel making processes/cleanliness, casting mold details, forging reduction ratio, etc.) (likelihood of cracking and critical locations)
iii. Redundancy of equipment (influence on consequence of failure)
iv. The stage of manufacturing*
v. In-service local high stress concentrations
vi. The anticipated in-service fatigue loading
vii. Product size
viii. Type of defect, longitudinal or rounded
ix. Cracks produced during secondary processing (forging, welding, heat treatment or surface hardening)

Note: * Where ultrasonic testing is specified for direct load path components, it is more effective to UT basic shapes than to UT a finished component containing complex profiles, shapes, or details.

25.1.1 Heat Treatment

All test specimens are to be representative of the components in the jacking system and in accordance with Chapter 3 of the above referenced Part 2. Representative specimens are to be of the same material grade, from the same heat and heat treatment batch, and are to be of sufficient size and mass to represent the heat transfer experienced in the components themselves during the complete heat treatment cycle.

Components and test material are to be heat treated together in the same furnace, and quenched in the same bath/tank (for Q & T components).

25.1.2 Surface Hardening

Where it is intended to surface harden climbing pinion teeth, full details of the proposed procedure and specification are to be submitted for approval. The manufacturer/heat treater is required to demonstrate by test that the proposed procedure gives a uniform surface layer of the required hardness and depth and that it does not impair the soundness and properties of the steel. Test specimens are to be representative of the climbing pinion and in accordance with Chapter 3 of the above referenced Part 2. Representative specimens are to be of the same material grade, from the same heat and heat treatment batch, and are to be of sufficient size and mass to represent the heat transfer experienced in the pinions themselves during the complete heat treatment cycle, including the surface hardening cycle.

For other surface hardened gearing, recognized national or international standards are to be applied.

25.3 Prototype Test

A prototype test is to be performed on one unit of a newly designed rack and pinion system as part of the design approval procedure. The prototype testing and examination is to be carried out in the presence of, and to the satisfaction of, the Surveyor.

The prototype test procedure is to be submitted for review and as a minimum is to include the following:

i. It is to be confirmed that the prototype has been manufactured to similar processes and materials, and according to the approved material specification, as that applied for the production units.
ii. Prior to the prototype test, all pinions and gears of the climbing pinion gear train are to be examined using an approved crack detection procedure. (ABS material certificates as per 6-1-9/25.1 are to be provided for the prototype unit.)
iii. The prototype test is to be carried out at 150% of the maximum normal holding capacity rating of the unit. As a minimum, the test is to be carried out for one complete revolution of the climbing pinion.
iv. Subsequent to the prototype test, the unit is to be disassembled and examined. All pinions and gears of the climbing pinion gear train are to be examined using an approved crack detection procedure.

25.5 Replacement Jacking Equipment for Units in Operation

The following requirements apply to all jacking components, rack fixation systems, and associated equipment.

25.5.1 Design

Replacement components may be fabricated using original designs that were accepted in accordance with the same or earlier Rules.

Replacement components may be fabricated in accordance with designs approved to Rules more recent than the unit's contract date.

25.5.2 Material and Heat Treatment

Material manufacturers are to be ABS approved in accordance with Chapters 1 to 3 of the ABS *Rules for Materials and Welding (Part 2)*.

The approval scope is to include all heat treatment facilities used by the manufacturer in the production of jacking components.

Replacement components may be fabricated using original material specifications, or to specifications accepted by ABS engineering department.

25.5.3 Fabrication and testing

Components are to be fabricated to the satisfaction of the attending Surveyor in accordance with the following requirements:

i. Inspection and material testing is to be conducted in accordance with 6-1-9/25.1 Testing is to include the following items:
   a. Physical/mechanical properties:
      - Yield strength
      - Ultimate tensile strength
      - Percent elongation
      - Reduction of area
      - Charpy Impacts
        - Are to be taken in locations specified by 6-1-9/9.1
        - Values are to be in accordance with the design
      - Hardness Values
   b. Nondestructive Testing (NDE) Requirements

25.5.4 Installation

Certification conducted for components using this section will only be valid for use on units with a contract date the same as or previous to the elevating system's design approval date.

25.5.5 Reconditioning of Existing Equipment

Existing equipment removed from a unit Classed with ABS may be reconditioned and used as replacement equipment on a unit with the same Rule requirements.

All existing components that are reconditioned or repaired by welding are to have the testing listed above conducted were applicable.

Weld procedures are to be qualified by using actual components and tested in accordance with the complete list above.

TABLE 2
Certification Details – Jacking and Associated Systems[1,3]

Jacking and Associated Systems	Material Certification	NDE	Functional/ Load test	ABS Type Approval Tier	Rule Reference
Material of load carrying components					
Rack and jack-case for rack and pinion units	X	X	-	5	6-1-9/9
Jacking pins and yoke for hydraulic actuated units	X	X	-	5	6-1-9/9
Material of torque transmitting parts					
Climbing pinion	X	X	-	5	6-1-9/9
Gears	X	X	-	5	6-1-9/9
Pinions	X	X	-	5	6-1-9/9
Planetary carriers	X	X	-	5	6-1-9/9
Pins	X	X	-	5	6-1-9/9
Shafts	X	X	-	5	6-1-9/9
Torque Supports	X	X	-	5	6-1-9/9
Torque flanges	X	X	-	5	6-1-9/9
Couplings	X	X	-	5	6-1-9/9
Couplings bolts	X	X	-	5	6-1-9/9
Jacking Gear Motor shafts (regardless of Motor rating) when integral to braking or in the load path	X[2]	X	-	5	6-1-9/9, 6-1-9/15.1
Holding mechanism (e.g., fixation system) components in the load path	X	X	-	5	6-1-9/9
Assembled Gear Box Unit	-	-	X	5	6-1-9/25
Assembled Hydraulic Power Units	-	-	X	5	6-1-9/17
Brakes	-	-	-	2	6-1-9/13.3
Bearings	-	-	-	1	6-1-9/13.1
Flexible shock pads	-	-	-	2	6-1-9/13.5
Electric motors >100 kW (135 hp)	-	-	X	5	6-1-7/19.1 and 6-1-9/15.1
Electric motors ≤ 100 kW (135 hp)	-	-	-	2	6-1-9/15.1
Hydraulic jacking motors	-	-	X	4/5	6-1-9/17.1
Hydraulic system components in the load path, for jacking unit and holding mechanism, including hydraulic cylinders and actuators	-	-	X	5	6-1-9/17
Hydraulic system components of standard design not in the load path, for jacking unit and holding mechanism, including hydraulic cylinders and actuators	-	-	-	1	6-1-9/17
Hydraulic system components of non-standard design not in the load path, for jacking unit and holding mechanism, including hydraulic cylinders and actuators	-	-	-	2	6-1-9/17
System control, monitoring and alarms	-	-	X	5	6-1-9/19

Notes:

1. All jacking and associated systems are to comply with 6-1-9/25.
2. ABS to witness a hardness test only at accessible location on the motor shaft, to verify hardness is within manufacturer specification. Other mechanical tests and NDE need not be ABS witnessed.
3. Components need not be individually design approved/ type approved if they are part of an assembly that is type approved.

9 Production Welding

Production welding and forming of steel is to be to the satisfaction of the Surveyor and in accordance with Section 2-4-1 of the ABS *Rules for Materials and Welding (Part 2)*

9.1 Thickness in Excess of 50 mm (2 in.)

Special precautions with regard to joint preparation, preheat, welding sequence, heat input, and interpass temperature are to be taken for welding thick sections. Ultrasonic Testing (UT) to confirm the absence of injurious laminations may be required for material used where through-thickness (Z direction) properties are important. Stress relieving, when specified, is to be carried out using an approved method.

9.3 Inspection of Welds

All welds are to be subject to visual inspection. Representative Nondestructive Testing (NDT) is to be carried out to the satisfaction of the Surveyor. Such testing is to be carried out after all forming and post weld heat treatment. Welds which are inaccessible or difficult to inspect in service may be subjected to increased levels of NDT.

9.5 Fillet Welds

Completed welds are to be to the satisfaction of the attending Surveyor. The gaps between the faying surfaces of members being joined should be kept to a minimum. The standards in the accepted QCP are to be followed except when authorized otherwise by the Surveyor.

Where small fillets are used to attach heavy plates or sections, special precautions such as the use of preheat or low-hydrogen electrodes or low-hydrogen welding processes may be required. When heavy sections are attached to relatively light plating, the weld size may be required to be modified.

11 Nondestructive Testing (NDT) *(2025)*

Prior to commencement of any NDT, an NDT plan is to be submitted to the attending Surveyor for review and acceptance, and is to conform to 2-4-1/5.17 of the ABS *Rules for Materials and Welding (Part 2)* and 7A-1-2/9.3 of these Rules. NDT is to be carried out in accordance with the ABS *Requirements for Nondestructive Testing (NDT Requirements)*.

All NDT procedures are to be reviewed and accepted by the Surveyor before commencement of NDT. Radiographic Testing (RT), Ultrasonic Testing (UT), Magnetic Particle Inspection (MPI), Penetrant Testing (PT), Eddy Current (EC) or Alternating Current Field Measurement (ACFM) is to be carried out to the satisfaction of the Surveyor. With the exception of RT, the Surveyor may require witnessing the NDT carried out by a qualified technician.

11.1 NDT of Column-Stabilized Units

Complete Joint Penetration (CJP) butt welds, tee welds, and corner welds, in the following areas of a column-stabilized unit are to be specifically subjected to NDT during construction:

i. Fabrication/erection joints of pontoons, columns, bracings, diagonals, and upper deck structure (forming a box girder)
ii. Columns to pontoons or lower hulls
iii. Column to braces
iv. Columns to upper hull
v. Braces to upper hull
vi. Brace-to-brace intersections
vii. Gussets and brackets in way of the above joints
viii. Internal continuation or back-up structure of the above joints
ix. Any temporary access closures or inserts in main structures

11.3 NDT of Self-Elevating Units

Complete Joint Penetration (CJP) butt welds, tee welds, and corner welds, in the following areas of a self-elevating unit are to be specifically subjected to NDT during construction:

i. Lattice-type leg structure; including chords, braces, racks, and rack attachments
ii. Lattice-type leg gussets
iii. Cylindrical-type leg shell structure
iv. Fabrication/erection joints of spud-cans or mat
v. Leg to spud-can or mat connections
vi. Jackcase (jackhouse) to deck connections
vii. Any temporary access closures or inserts in main structures

11.5 NDT of Surface-Type Units

Complete Joint Penetration (CJP) butt welds, tee welds, and corner welds, within the midship 0.6*L* of a surface-type unit are to be specifically subjected to NDT during construction:

i. Intersections of butts and seams in the sheer strakes, bilge strakes, deck stringer plates, and keel plates
ii. Intersections of butts in and around moonpool corners on main deck and bottom plating
iii. In the vicinity of breaks in the superstructure
iv. Support stools and foundations for deck structures
v. Any temporary access closures or inserts in main structures

At the discretion of the Surveyor, NDT outside the midship 0.6*L* is to be carried out at random.

11.7 Type and Extent of NDT

The percentage of weld joint to be subjected to NDT and type of NDT carried out (e.g., Radiographic Testing (RT), Ultrasonic Testing (UT), Magnetic Particle Inspection (MPI), Penetrant Testing (PT), Eddy Current (EC), or Alternating Current Field Measurement (ACFM)) will depend on the design of the unit and the calculated fatigue life of the joint.

The minimum extent of NDT to be carried out is shown in 7A-1-2/Table 1. Volumetric NDT techniques include RT and UT. Surface NDT techniques include MPI, PT, EC, or AFCM.

Additional NDT may be requested by the Surveyor if the quality of fabrication or welds is not in accordance with these Rules and applicable Standards.

TABLE 1
Nondestructive Testing* (NDT) of Steel Structure Welds (2025)

Structural Member	Extent and Type of NDT
Special Application Structure (Most Critical)	100% Volumetric NDT plus 100% Surface NDT all CJP welds, where welded plate thickness is ≥ 5/16 inch (8.0 mm); and 10% MPI of all fillet welds, where plate thickness is ≥ 5/16 inch (8.0 mm).
Primary Application Structure (Intermediate)(1)	20% Volumetric NDT plus 100% Surface NDT of all CJP welds, where plate thickness is ≥ 5/16 inch (8.0 mm); and 10% Surface NDT of all fillet welds, where plate thickness is ≥ 5/16 inch (8.0 mm).
Secondary Application Structure (Least Critical)	Random Volumetric NDT of CJP welds and Surface NDT of fillet welds, only if considered suspect by the attending Surveyor during construction.

***NDT procedures and acceptance criteria are to at least satisfy the *NDT Requirements*.

1 Extent of surface NDT for all automatic welding of CJP welds may be reduced to 20% for base materials of < 400 MPa (58 ksi) yield strength, as applicable.

11.9 NDT Personnel and Records **(2025)**

The builder's NDT department is to be independent from other departments and not working for production.

NDT personnel are to be certified in accordance with the *NDT Requirements*. All NDT results and evidence are to be made available to the ABS Surveyor for review.

All NDT records are to be properly maintained at least until the delivery of the unit, and be available to the Surveyor upon request anytime during construction.

11.11 NDT Acceptance Standards **(2025)**

Class A and Class B acceptance standards of the *NDT Requirements* will be applicable as follows:

i. Class A acceptance criteria are to be used for NDT of welds of hull structure categorized as "Special Application Structure" or "Primary Application Structure" in accordance with 3A-1-4/5.

ii. Class B acceptance criteria are to be used for NDT of welds of hull structure categorized as "Secondary Application Structure" in accordance with 3A-1-4/5 and other locations where Class A acceptance criteria do not apply.

iii. Modified procedures and acceptance criteria are to be specified to reflect the application when radiographic or ultrasonic inspection is specified for other type connections such as partial penetration and groove type Tee or corner welds.