RULES FOR BUILDING AND CLASSING

STEEL FLOATING DRY DOCKS
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RULES FOR BUILDING AND CLASSING

STEEL FLOATING DRY DOCKS

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CHAPTER 1 General

SECTION 1 Definitions

1 Application

The following definitions apply throughout these Rules.

3 Length

L_m is the molded length, in m (ft), between the end bulkheads of the lifting portion of the dry dock in its normal operating mode.

L_{oa} is the length overall, in m (ft), and indicates the extreme length over aprons.

5 Breadth

B is the greatest horizontal distance, in m (ft), between the outer surfaces of the outer side plating of the wing walls.

B_O is the greatest horizontal distance, in m (ft), between the outer surfaces of the outer wing walls or fixed projections thereon

B_I is the least breadth, in m (ft), between the inner sides of the wing wall surfaces measured at the top of the keel blocks.

B_{IC} is the least breadth, in m (ft), between inner wing wall surfaces, or fixed projections thereon, measured at any point above the keel blocks.

7 Depth

D is the molded depth, in m (ft), measured at the centerline from the inner surface of the bottom plating to the inner surface of the top deck plating.

9 Clear Draft

d_c is the distance, in m (ft), from the top of the keel blocks to the waterline corresponding to the wing wall freeboard.

11 Safety Deck

The *Safety Deck* is a watertight deck extending over the length of the wing walls and located below the top deck.

13 Top Deck

The *Top Deck* is the deck extending over the length of the wing walls to form the top of the wing walls.

15 Pontoon

The *Pontoon* is the structure that extends between and under the wing walls to form the bottom of the dock.

17 Residual Water

Residual Water is water which cannot be discharged by pumps from ballast compartments.

19 Ballast Water

Ballast Water is the water, other than residual water, used in ballast compartments.

21 Lifting Capacity

The lifting capacities given below are to be with all dry dock service tanks full and operating equipment in place. In determining the dry dock lifting capacities, account is to be taken of the residual water defined in 3-1-1/17, or any ballast water required for longitudinal strength purposes.

21.1 Rated Lifting Capacity

The R*ated Lifting Capacity* is the ship weight, in metric tons (long tons), that the dry dock can lift and support in a satisfactory condition at the rated pontoon freeboard.

21.3 Maximum Lifting Capacity

The *Maximum Lifting Capacity*, in metric tons (long tons), is the ship weight that the dry dock can lift and support in a satisfactory condition at the minimum pontoon freeboard.

23 Buoyancy Chamber

A *Buoyancy Chamber* is a watertight compartment in the wing walls or pontoon, designed to be empty at all times and provided with neither filling lines nor flooding valves.

25 Units

These Rules are written in two systems of units, i.e., MKS units and US customary units. Each system is to be used independently of any other system.

Unless indicated otherwise, the format of presentation in the Rules of the two systems of units is as follows:

MKS units (US customary units)

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CHAPTER 1 General

SECTION 2 General Requirements

1 Material

The material for the structural members of dry docks having operating sites in sheltered waters is to be hull structural steel, castings, etc., complying with the relevant requirements of the ABS *Rules for Materials and Welding (Part 2)*. Steel plate and rolled sections are generally to be of Grade A material. Attention is to be given to the notch toughness of the material for dry docks that are to operate in low temperature environments, in unprotected locations, or are to undergo an ocean delivery voyage.

3 General Arrangement

3.1 Safety Deck

A watertight safety deck as defined in 3-1-1/11 is to be fitted. When all tanks below the safety deck are flooded, the dry dock is to remain afloat at a draft no greater than that corresponding to the wing wall freeboard. Alternative arrangements to fitting a safety deck, such as the provision of an air cushion, will be given special consideration. Special consideration will also be given to the need for a safety deck in relation to the depth of water in which the dry dock operates.

3.3 Top Deck

The dry dock is to be provided with a top deck as defined in 3-1-1/13. Where a watertight safety deck is required, the top deck is to be weathertight ('weathertight' in this case meaning the ability to exclude water other than that due to rainfall in way of necessary access openings). Special consideration will be given to the top deck, including the scantlings, where air cushions are proposed in lieu of a safety deck.

3.5 Ventilation and Access

All ballast and service tanks are to have vent or overflow pipes that generally terminate above the top deck. All compartments are to be provided with manholes for access, and openings are to be arranged to provide adequate ventilation and access to all parts of the structure.

5 Indicator Systems

Deflection meters or acceptable alternatives, tank level, draft, and trim indicators are to be provided to enable the operation of the dry dock to be controlled within the draft and deflection limits.

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CHAPTER 2 Hull Structures and Arrangements

SECTION 1 Longitudinal Strength

1 Loading Conditions *(2020)*

The longitudinal strength is to be determined from the data given for a ship having a weight equal to the maximum lifting capacity of the dry dock. Longitudinal bending moments and shear forces are to be investigated for the condition in which the weight of the vessel is distributed, in an acceptable form, over a length corresponding to the shortest vessel intended to be lifted and supported at the maximum lifting capacity of the dry dock. Where governing bending moments and shear forces may occur at less than the maximum lifting capacity such conditions are also to be investigated.

Information on the loading conditions is to be contained in the operating manual, including the length of the shortest vessel used to determine the bending moment and shearing forces at the maximum lifting capacity. Information on the shortest vessel that may be docked at the various other lifting capacities is also to be indicated in the operating manual, as well as the longitudinal deflections of the dry dock associated with the maximum allowable bending moment for which the dock is approved.

Alternatively, consideration will be given to the approval of the dry dock based on allowable operating deflections that have been established from satisfactory service with dry docks of specific size, proportion, and scantlings. For approval, the proposed maximum allowable values of deflection along the length of the dock and the longitudinal bending moments and shear forces associated with them are to be submitted.

Where it is intended to tow the dry dock in unprotected waters, the dry dock is to comply with the requirements stated in 3-2-1/9.

3 Permissible Stresses

For the loading conditions defined in 3-2-1/1, the longitudinal bending stresses are not to exceed 1400 kg/cm^2 (8.9 long $tons/in^2$) and the shear stresses are not to exceed 787 kg/cm^2 (5.0 long $tons/in^2$). Alternatively, the design stresses may be in accordance with other recognized standards, provided all related requirements of the standard are also complied with. Where approval is based upon allowable deflection standards established by satisfactory service experience, the associated permissible stresses may vary from those given above.

5 Extent of Scantlings

The scantlings of members included in the dry dock mid-length section modulus are to be maintained over the $0.4L_m$ mid-length of the dry dock, beyond which they may be gradually reduced towards the ends. Where the maximum bending moment is outside the $0.4L_m$ mid-length of the dry dock, special consideration will be given to the longitudinal distribution of material. The requirements of Section 3-2-2 and Section 3-2-3 are also to be complied with.

7 Deflection Indicator Systems

The deflection indicator systems as required by 3-1-2/5 are to provide a means by which the operating personnel can promptly see the effects of loading on the longitudinal strength. The allowable deflection limits are to correspond to the governing longitudinal bending condition for which the dock is approved and are to be readily apparent to operating personnel. Where anticipated as operating conditions, the deflection control systems are to be capable of showing the effects on the longitudinal strength of load discontinuities resulting from conditions such as supporting a vessel in two or more parts or the simultaneous support of two or more vessels. Information on the deflection indicator system, including the limits of allowable deflection, is to be included in the operating manual.

9 Dry Dock on Tow *(2018)*

9.1 General *(2020)*

Floating dry dock on tow is not within the scope of classification. At specific request from the Owner of the facility or shipyard, ABS may carry out a Statement of Compliance review for the requirements given in this section of the Rules.

Floating dry docks intended to be towed in unprotected waters are to have longitudinal strength in accordance with the requirements of this section.

Details of the transit conditions (including particulars of the season, environmental conditions/sea state, the duration, number of voyages, area of the towing operation) are to be submitted for review.

9.3 Strength Standard

The required hull girder section modulus SM_R amidships, to the top deck and bottom is to be obtained from the following equation:

$$SM_R = K \quad SM_b \qquad \text{cm}^2 - \text{m} \quad (\text{in}^2 - \text{ft})$$

where

K	=	$0.629 + M_s/(f_p SM_b)$ but is not to be taken less than 1.0	
M_s	=	maximum still-water bending moment in the governing loaded or ballasted condition in kN-m (tf-m, Ltf-ft). When still-water bending moment calculations are not submitted, K will be taken as 1.0.	
f_p	=	17.5 kN/cm^2 (1.784 tf/cm2, 11.33 Ltf/in^2)	
SM_b	=	$C_1 C_2 L^2 B(C_b + 0.7)$ cm^2 – m (in^2 – ft)	
C_1	=	4.11	$30 \le L < 45$ m
	=	$16.33(L/100)^2 - 15.47(L/100) + 7.77$	$45 \le L < 95$ m
	=	$10.75 - [(300 - L)/100]^{1.5}$	$95 \le L \le 300$ m
	=	10.75	$300 < L < 350$ m
	=	$10.75 - [(L - 350)/150]^{1.5}$	$350 \le L \le 500$ m
	=	4.11	$100 \le L < 150$ ft
	=	$16.33(L/328)^2 - 15.47(L/328) + 7.77$	$150 \le L < 310$ ft
	=	$10.75 - [(984 - L)/328]^{1.5}$	$310 \le L \le 984$ ft
	=	10.75	$984 < L < 1148$ ft
	=	$10.75 - [(L - 1148)/492]^{1.5}$	$1148 \le L \le 1640$ ft
C_2	=	$0.01(1.44 \times 10^{-4})$	
L	=	$0.97L_{wl}$	

L_{wl} = waterline length, in m (ft), of the pontoon structure

B = breadth, in m (ft), as defined in 3-1-1/5

C_b = block coefficient of the pontoon structure

9.5 Section Modulus Calculation

In general, the following items may be included in the calculation of the section modulus, provided they are continuous or effectively developed throughout the midship $0.4L$.

- Deck plating (top deck and other effective decks)
- Wing walls – shell and inner skin plating
- Pontoon structure
- Deck and bottom girders
- Plating and longitudinal stiffeners of longitudinal bulkheads, longitudinals of decks, wing walls and pontoon structure.

In general, the net sectional areas of longitudinal-strength members are to be used in the hull girder section modulus calculations. The section modulus to the top deck or bottom is obtained by dividing the moment of inertia by the distance from the neutral axis to the molded top deck line at side amidships or to the baseline, respectively.

9.7 Hull Girder Moment of Inertia

The hull girder moment of inertia I is to be not less than obtained from the following equation:

$$I = 0.03 SM_R L \qquad \text{cm}^2 - \text{m}^2 \quad (\text{in}^2 - \text{ft}^2)$$

where

L = length, in m (ft), as defined in 3-2-1/9.3

SM_R = hull girder section modulus required for the dry dock as per 3-2-1/9.3

Alternatively, the hull girder moment of inertia based on the permissible deflection limits may be considered on a case-by-case basis.

9.9 Still-water Bending Moment and Shear Force Calculations

Still-water bending moment and shear force calculations are also to be submitted for dry docks on tow, irrespective of their length. These calculations are to show bending moment and shear force values along the length of the dry dock.

In general, the thickness of the wing wall and pontoon's side shell and longitudinal bulkhead plating is to be such that calculated hull-girder shearing stress based on still-water conditions does not exceed 58 N/mm^2 (5.91 kgf/mm^2, 8406 psi) at the quarter-length points of the dry dock, 74 N/mm^2 (7.55 kgf/mm^2, 10667.5 psi) at amidships and at the ends. Elsewhere values are to be interpolated.

9.10 Environment Severity Factor and Wave Bending Moment *(2020)*

In the case that a towing route is specified by the client, a series of "Environmental Severity Factors" (ESFs) may be assigned to adjust the loadings and load effects, such as wave-induced hull girder loads, to reflect owner-specified route environments. Detailed descriptions of ESFs can be found in 3/1.1 of the ABS *Guide for Building and Classing Drillships (Drillship Guide)*, and the values of ESF are to be derived according to Appendix A1 of the *Drillship Guide*. Refer to 3-2-1/9.10 TABLE 1 for applicable reduction in Wave Bending Moment and Section Modulus requirement associated with derived ESF values.

TABLE 1
ESF and Associated Reduction in Wave Bending Moment and Section Modulus Requirement

ESF (β)	*Wave Bending Moment (WBM)*	*Section Modulus Requirement*
> 0.7	β* Rule based WBM	Not to be less than 85% of the unrestricted service (Rule) value.
≤ 0.7	0.7* Rule based WBM	

Note: For very benign conditions including sheltered water tow and inland tow, special consideration may be given, on a case by case basis, subject to satisfactory review of the Seakeeping Analysis.

9.11 Longitudinal Strength with Higher-Strength Materials

9.11.1 General

Dry docks in which the effective longitudinal material of either the upper or lower flanges of the main hull girder, or both, is constructed of materials having mechanical properties greater than those of ordinary-strength hull structural steel, are to have longitudinal strength generally in accordance with the preceding paragraphs of this Section, but the value of the hull girder section moduli may be modified as permitted by the following paragraph.

Applications of higher-strength material are to be continuous over the length of the dry dock to locations where the stress levels are suitable for the adjacent mild-steel structure. Higher-strength steel is to be extended to suitable locations below the top deck, pontoon deck and above the bottom, so that the stress levels will be satisfactory for the remaining mild steel structure. Longitudinal framing members are to be continuous throughout the required extent of higher-strength steel. Calculations showing that adequate strength has been provided against buckling are to be submitted for review.

9.11.2 Hull Girder Section Modulus

When either the top or bottom flange of the hull girder, or both, is constructed of higher-strength material, the section modulus as obtained from 3-2-1/9.3 may be reduced by the factor Q.

$$SM_{hts} = Q(SM_R)$$

where

Q = 0.78 for H32 Strength Steel

Q = 0.72 for H36 strength steel

H32 and H36 are as specified in Section 2-1-3 of the ABS *Rules for Material and Welding (Part 2)*.

Q factor for steels having other yield points or yield strength will be specially considered.

9.11.3 Hull Girder Moment of Inertia

The hull-girder moment of inertia is to be not less than required by 3-2-1/9.7 using the mild steel section modulus obtained from 3-2-1/9.3 .

9.13 Buckling Calculations

Where buckling calculations are required to be submitted to verify the acceptability of the thickness of decks, shell, longitudinal bulkheads, etc., the total hull girder bending moment to be used in the calculations is to consist of the maximum still-water bending moment in kN-m, (tf-m, Ltf-ft) plus a wave-induced bending moment of $S_w SM_b$, kN-m (tf-m, Ltf-ft) where S_w = 11.0 kN/cm2 (1.122 tf/cm^2, 7.123 Ltf/in^2).

Consideration will be given to the wave-induced bending moment calculated by means of a statistical analysis based on the ship motion calculation in realistic sea states. In such cases, the calculations, computer programs used, and the computed results are to be submitted for review.

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CHAPTER 2 Hull Structures and Arrangements

SECTION 2 Transverse Strength

1 Loading Conditions

The transverse strength of the dry dock is to be considered with the dry dock at the minimum pontoon freeboard and the keel blocks loaded to the maximum permissible value per m (ft) of length of dry dock indicated in the building specifications or operating manual. The maximum permissible keel block load is to be not less than determined from the data given for the shortest ship intended to be docked at the maximum lifting capacity of the dry dock with the vessel weight supported only by the keel blocks. Alternatively, where it is the operating condition, the weight corresponding to the shortest vessel to be docked at the maximum lifting capacity may be distributed on both the keel and side blocks. In such cases, the keel block load is also not to be less than that corresponding to the shortest heaviest vessel to be supported only by the keel blocks, and the transverse strength of the dock is to be considered for both conditions. With the dry dock at the minimum pontoon freeboard, consideration is to be given also to the effect on the transverse strength of the pontoon structure not subject to block loading. The maximum keel block load and the side block design loads as indicated in 3-2-3/7.1 need not be considered to apply simultaneously to a member supporting both unless it is anticipated as an operational loading arrangement.

The transverse strength of the dry dock is also to be considered with the dry dock at those drafts which give the maximum water pressure differential on the dock structure.

3 Permissible Stresses

Under the loading conditions in 3-2-2/1, the compressive or tensile stresses in transverse members are not to exceed 1600 kg/cm^2 (10.1 long tons/in^2). The shear stresses in the transverse members are not to exceed 1000 kg/cm^2 (6.3 long tons/in^2). Alternatively, the design stresses may be in accordance with other recognized standards, provided all related requirements of the standard are also complied with.

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CHAPTER **2 Hull Structures and Arrangements**

SECTION **3 Local Strength**

1 Buckling

The structural panels and members are to be adequately stiffened to prevent buckling. It may be required that calculations be submitted in support of resistance to buckling for any part of the vessel's structure.

3 Tank and Shell Scantlings

3.1 Plating

Plating is to be of the thickness obtained from the following equation.

$$t = \frac{s\sqrt{h}}{283} + 2.30 \text{ mm}$$

$$t = \frac{s\sqrt{h}}{511} + 0.09 \text{ in.}$$

where

s = spacing of stiffeners, in mm (in.)

h = for ballast tanks, the greatest of the following distances, in m (ft), from the lower edge of the plate:

i) To a point located at two-thirds of the distance from the top of the tank to the top of the overflow. As an alternative, the maximum differential head in service may be used, provided hydrostatic data is submitted to show the differential head based on the highest levels to which water will rise on each side of the structure in service. Where the head is obtained using the maximum differential head in service, data on operating the dry dock within such design limits are to be included in the operating manual.

ii) 2.5 m (8.2 ft)

= for all other tanks, the greatest of the following distances, in m (ft), from the lower edge of the plate:

i) To a point located two-thirds of the distance from the top of the tank to the top of the overflow

ii) To the maximum immersion waterline, for wing wall and pontoon plating

iii) 2.5 m (8.2 ft)

= for void spaces and cofferdams, the greater of the following distances, in m (ft), from the lower edge of the plate:

i) To the maximum immersion waterline, for wing wall and pontoon plating

ii) 2.5 m (8.2 ft)

The thickness is not to be less than 6.5 mm (1/4 in.). Special consideration is to be given to the required plating thickness where it forms the boundary of an air cushion.

The arrangement of all tanks, showing the maximum heads to which they will be subjected in service and the heights of all overflow and vent pipes, is to be clearly indicated on the submitted plans.

3.3 Stiffeners

Each stiffener, in association with the plating to which it is attached, is to have section modulus, SM, not less than obtained from the following equation:

$SM = 6.75hs\ell^2$ cm^3

$SM = 0.0035hs\ell^2$ in^3

where

h = for ballast tanks, the greatest of the following distances, in m (ft), from the middle of ℓ:

- *i)* To a point located at two-thirds of the distance from the top of the tank to the top of the overflow. As an alternative, the maximum differential head in service may be used, provided hydrostatic data is submitted to show the differential head based on the highest levels to which water will rise on each side of the structure in service. Where the head is obtained using the maximum differential head in service, data on operating the dry dock within such design limits are to be included in the operating manual.
- *ii)* 2.5 m (8.2 ft)

= for all other tanks, the greatest of the following distances, in m (ft), from the middle of ℓ:

- *i)* To a point located two-thirds of the distance from the top of the tank to the top of the overflow
- *ii)* To the maximum immersion waterline, for wing wall and pontoon plating
- *iii)* 2.5 m (8.2 ft)

= for void spaces, the distance, in m (ft), from the middle of l to the maximum immersion waterline for wing wall and pontoon stiffeners, but not less than 2.5 m (8.2 ft) for wing wall, pontoon, and bulkhead stiffeners.

s = spacing of the stiffeners, in m (ft)

ℓ = span, in m (ft), between effective supporting members. Where brackets complying with 3-2-3/9 TABLE 1 are fitted at bulkheads, decks, or shell and intersect the stiffeners at about 45 degrees, the spanℓ may be measured to a point 25% of the extent of the bracket beyond the bracket toe.

Special consideration is to be given to the scantlings of stiffeners supporting plating which forms the boundary of an air cushion.

3.5 Stringers, Webs, and Girders

3.5.1 Strength Requirements

Each stringer, web, or girder which supports stiffeners is to have a section modulus, SM, not less than obtained from the following equation:

$SM = 6.75hs\ell^2$ cm^3

$SM = 0.0035hs\ell^2$ in^3

where

h = vertical distance, in m (ft), from the center of the area supported to the same heights to which h for the stiffeners is measured (see 3-2-3/3.3)

s = spacing of stringers, webs, and girders, in m (ft)

ℓ = span, in m (ft), between effective supporting members. Where effective brackets are fitted, ℓ may be modified as indicated in 3-2-3/3.5.3. Where efficient struts are fitted across tanks connection stringers, webs, or girders on each side of the tanks and spaced not over four times the depth of the girder, the value for the section modulus, SM , for each stringer, web, or girder may be one-half that given above.

3.5.2 Proportions

The web depth is not to be less than 0.145ℓ (1.75 in. per ft of span ℓ) where no struts or ties are fitted, and 0.0833ℓ (1 in. per ft of span ℓ) where struts or ties are fitted or where the member is a deck girder or deck transverse. In general, the depth is not to be less than 3 times the depth of the slots for stiffeners, and the thickness is not to be less than 1 mm per 100 mm (0.01 in. per in.) of depth plus 3 mm (0.12 in.), but need not exceed 11.5 mm (0.46 in.).

3.5.3 Brackets

Where brackets are fitted having thicknesses of not less than the stringer, web, or girder web plates, the value for ℓ may be modified in accordance with the following:

- Where the face area on the bracket is not less than one-half that on the stringer, web, or girder and the face plate or flange on the stringer, web, or girder is carried to the bulkhead or base, the length ℓ may be measured to a point 150 mm (6 in.) onto the bracket. In no case is the allowance at either end to exceed one-quarter of the overall length of the stringer, web, or girder.
- Where the face area on the bracket is less than one-half that on the stringer, web, or girder and the face plate or flange on the stringer, web, or girder is carried to the bulkhead or base, ℓ may be measured to a point where the area of the bracket and its flange, outside the line of the stringer, web, or girder is equal to the flange area on the girder.
- Where the face plate or flange area of the stringer, web, or girder is carried along the face of the bracket, which may be curved for the purpose, ℓ may be measured to the point of the bracket.

Brackets are not to be considered effective beyond the point where the arm on the girder or web is 1.5 times the length of the arm on the bulkhead or base.

5 Decks

5.1 Plating

5.1.1 Top Deck

The thickness of top deck plating over the $0.4L_m$ mid-length of the dry dock is to be as required for longitudinal strength, see 3-2-1/1, 3-2-1/3, 3-2-1/5, and 3-2-3/1. (See also 3-1-2/3.3.) Outside the $0.4L_m$ mid-length the plate thickness may be gradually reduced until for $0.1L_m$ from each end of the dry dock it is to be not less than determined from the following equations:

$t = 0.0095s + 0.86$ mm $\quad s \le 760$ mm

$t = 0.0095s + 0.033$ in. $\quad s \le 30$ in.

$t = 0.0064s + 3.2$ mm $\quad s > 760$ mm

$t = 0.0064s + 0.127$ in. $\quad s > 30$ in.

where

t = required thickness of deck plating, in mm (in.)

s = spacing of longitudinals or transverse beams, in mm (in.)

5.1.2 Safety Deck

The thickness of the safety deck is to be in accordance with 3-2-3/1 and 3-2-3/3.1, but is generally to be not less than 7.0 mm (0.28 in.). Special consideration is to be given to the thickness where the deck forms an air cushion boundary.

5.3 Longitudinals and Beams

5.3.1 Top Deck

In general, the top deck is to be framed longitudinally over the $0.4L_m$ mid-length of the dry dock. The section modulus,SM, of each top deck longitudinal or transverse beam is to be obtained from the following equation:

$$SM = 12.04cs\ell^2 \quad \text{cm}^3$$

$$SM = 0.0205cs\ell^2 \quad \text{in}^3$$

where

c = 0.874 for longitudinals within the $0.4L_m$ mid-length of the dry dock

= 0.55 for transverse beams throughout and for longitudinals within $0.1L_m$ from the end of the dry dock. The c value for longitudinals between the $0.4L_m$ mid-length and the end $0.1L_m$ lengths of the dry dock may be obtained by interpolation between the two above indicated values. Where the maximum longitudinal bending moment is outside the $0.4L_m$ mid-length of the dry dock, special consideration will be given to the value of c for top deck longitudinals.

s = spacing of longitudinal or transverse beams, in m (ft)

ℓ = span, in m (ft), between effective supporting members. Where brackets complying with 3-2-3/9 TABLE 1 are fitted at bulkhead, deck, or shell supports and intersect the longitudinal or beam at about 45 degrees, the span ℓ may be measured to a point 25% of the extent of the bracket beyond the bracket toe.

In way of tanks and if greater than the foregoing, the requirements of 3-2-3/3.3 are to apply.

5.3.2 Safety Deck

The section modulus, SM, of each safety deck longitudinal or transverse beam is to be obtained from the following equation:

$$SM = 4.27hs\ell^2 \quad \text{cm}^3$$

$$SM = 0.0022hs\ell^2 \quad \text{in}^3$$

where

h	=	height from the top of the safety deck to the underside of the top deck plating, in m (ft)
s	=	spacing of longitudinals or beams, in m (ft)
ℓ	=	span, in m (ft), between effective supporting members. Where brackets complying with 3-2-3/9 TABLE 1 are fitted at bulkhead, deck, or shell supports and intersect the longitudinal or beam at about 45 degrees, the span ℓ may be measured to a point 25% of the extent of the bracket beyond the bracket toe.

In way of tanks, and if greater than the foregoing, the requirements of 3-2-3/3.3 are to apply. Special consideration is to be given to the scantlings where the deck forms an air cushion boundary.

5.5 Deck Transverses and Girders

The section modulus, SM, of each top and safety deck member supporting longitudinals or beams is to be obtained from the following equation:

$$SM = 4.74hs\ell^2 \quad \text{cm}^3$$

$$SM = 0.0025hs\ell^2 \quad \text{in}^3$$

where

h	=	1.52 m (5 ft) for top deck members for safety deck members
	=	height from the top of the safety deck to the underside of the top deck plating, in m (ft)
s	=	spacing of deck transverses or girders, in m (ft)
ℓ	=	as defined in 3-2-3/3.5, in m (ft)

Clear of tanks, the depth of deck transverse or girder is to be not less than 0.0583ℓ (0.7 in. per ft of span ℓ). In way of tanks, the proportions given in 3-2-3/3.5.2 are to apply.

The span ℓ may be modified for brackets in accordance with 3-2-3/3.5.3. In way of tanks, and if greater than the foregoing, the requirements of 3-2-3/3.5 are to apply.

Special consideration is to be given to the scantlings of deck girders and transverses where the deck forms an air cushion boundary.

7 Structure Under the Keel and Side Blocks

7.1 Loading

The loading on the keel blocks is to be the maximum permissible value per m (ft) of dry dock length given in the building specifications or operating manual, but is not to be less than that determined from the data given for the shortest ship intended to be docked at the maximum lifting capacity of the dry dock with the vessel weight supported only by the keel blocks. Alternatively, where it is the operating condition, the weight corresponding to the shortest vessel to be docked at the maximum lifting capacity may be distributed on both the keel and side blocks. In such cases, the keel and side blocks load is also not to be less than that corresponding to the shortest, heaviest vessel to be supported only by the keel blocks. In the absence of other standards or specifications, the side block design load is not to be less than one-half that of the keel blocks. The maximum keel block load and the design side block loads need not be applied simultaneously to a member supporting both unless it is anticipated as an operational loading condition.

7.3 Structural Arrangement

A centerline girder is to provide adequate support for the keel blocks. Side girders or transverse members are to be arranged to support the side blocks. The block loading on local supporting members is to be as given in 3-2-3/7.1.

7.5 Permissible Local Stresses

In association with the local loading given in 3-2-3/7.1, the tensile or compressive stress is not to exceed 1600 kg/cm^2 (10.1 long tons/in^2). The shear stresses are not to exceed 1000 kg/cm^2 (6.3 long tons/in^2). Alternatively, the design stresses may be in accordance with another recognized standard, provided all the related requirements of the standard are also complied with.

9 Dock Cranes

If cranes are fitted, the resulting loads on the dry dock structure are to be indicated on the submitted plans. The total crane weight including hook load and the arrangement of wheels and rails are to be taken into consideration in determining the crane foundations. This information is to be indicated on the submitted plans. Certification for the cranes, if required, will be subject to special consideration.

TABLE 1
Thickness and Flanges of Brackets and Knees

Millimeters

Depth of Longer Arm	*Thickness*		*Width of Flange*
	Plain	*Flanged*	
150	6.5		
175	7.0		
200	7.0	6.5	30
225	7.5	6.5	30
250	8.0	6.5	30
275	8.0	7.0	35
300	8.5	7.0	35
325	9.0	7.0	40
350	9.0	7.5	40
375	9.5	7.5	45
400	10.0	7.5	45
425	10.0	8.0	45
450	11.5	8.0	50
475	11.0	8.0	50
500	11.0	8.5	55
525	11.5	8.5	55
550	12.0	8.5	55
600	12.5	9.0	60
650	13.0	9.5	65
700	14.0	9.5	70
750	14.5	10.0	75
800		10.5	80
850		10.5	85
900		11.0	90
950		11.5	90
1000		11.5	95
1050		12.0	100
1100		12.5	105
1150		12.5	110
1200		13.0	110

Inches

Depth of Longer Arm	*Thickness*		*Width of Flange*
	Plain	*Flanged*	
6.0	0.26		
7.5	0.28		
9.0	0.30	0.26	1 1/4
10.5	0.32	0.26	1 1/4
12.0	0.34	0.28	1 1/2
13.5	0.36	0.28	1 1/2
15.0	0.38	0.30	1 3/4
16.5	0.40	0.30	1 3/4
18.0	0.42	0.32	2
19.5	0.44	0.32	2
21.0	0.46	0.34	2 1/4
22.5	0.48	0.34	2 1/4
24.0	0.50	0.36	2 1/2
25.5	0.52	0.36	2 1/2
27.0	0.54	0.38	2 3/4
28.5	0.56	0.38	2 3/4
30.0	0.58	0.40	3
33.0		0.42	3 1/2
36.0		0.44	3 1/2
39.0		0.46	3 3/4
42.0		0.48	4
45.0		0.50	4 1/4

Note: The thickness of brackets is to be suitably increased in cases where the depth at throat is less than two-thirds that of the knee.

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CHAPTER 2 Hull Structures and Arrangements

SECTION 4 Welding and Corrosion Control

1 Welding

Welding is to be in accordance with the ABS *Rules for Materials and Welding (Part 2)* and Section 3-2-19 of the ABS *Marine Vessel Rules*. Alternatively, welding may be in accordance with another recognized standard, provided all related requirements of the standard are also complied with.

3 Corrosion Control

Where special protective coatings are applied to the boundaries and internal framing members, or other effective methods of corrosion control are adopted, reductions in scantlings may be specially considered.

Where any of the proposed reductions are approved, a notation will be made in the Record that such reductions have been taken.

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CHAPTER **2** **Hull Structures and Arrangements**

APPENDIX **1** **Guidance on Hull Structural Modeling and Analysis (2018)**

1 General

The intent of this Appendix is to provide guidance on the use on fine element methods (FEM) for evaluating the structural strength of the floating dry dock for the considered loads.

1.1 Submittal Items

Submit a complete report documenting the analysis along with all structural drawings pertaining to the extent of the structure that is being analyzed. The finite element model is to be submitted for review along with analysis report.

The report is to include the following background information of the analysis:

i) The list of drawings/plans used in analysis, including their versions and dates.

ii) Detailed descriptions of structural modeling principals and any deviations in the model from the structural drawings.

iii) Plots of the structural models.

- Geometry
- Plate thickness

iv) Material properties and beam properties, if applicable.

v) Details of boundary conditions applied

vi) All loading conditions analyzed

vii) Data for load application*

viii) Summaries and plots of calculated deflections and reactions. Validate the load direction and global balance in the model.

ix) Summaries and plots of calculated stresses

x) Details of buckling assessments, if necessary

xi) Comparison table for design/drawing scantlings and FEA model scantlings

xii) Reference of software used in analysis, including its version and date

Note: Details on how loads (static, dynamic, impact, etc.) are determined for structural evaluation

3 Structural Modeling

3.1 Finite Element Types

The choice of the type of finite element is guided by the complexity of the structural system or component being analyzed, the level of detail desired, and the outcomes measured. Two node line element and three or four node membrane/plate element are considered sufficient for representation of a structure and requirements in this Section assumes the use of such element types in the models. Higher order elements may also be applied. Details of basic element types are given in 3-2-A1/Table 1.

TABLE 1
Finite Element Types *(2018)*

Element Type	*Description*
Rod (or truss) element	Line element with axial stiffness only and constant cross-sectional area along length of the element.
Beam element	Line element with axial, torsional and bi-directional shear and bending stiffness and with constant properties along the length of the element.
Membrane (or plane-stress) element	Plate element with in-plane stiffness and with constant thickness.
Shell (or bending plate) element	Plate element with in-plane and out-of-plane bending stiffness and with constant thickness.

3.3 Modeling Guidance

i) The model should include, as applicable, all primary load-carrying members of the structure being analyzed. Secondary structural members that may significantly affect load distributions and local response of the primary members may also be appropriately included in the model.

ii) For beam elements, cross sectional properties are to be based on an effective width of the attached plating. The effective width of plating of beam elements is not to exceed the sum of one-half of the spacing on either side of the structural member or 1/3 of the unsupported span of the member, whichever is less.

iii) Plate element meshing is to follow the stiffening system as far as practicable. The mesh size used should be adequate to represent the overall stiffness of the considered structure. For meshing of large systems such as deck, shell or bulkhead plate/framing systems, the mesh size is to not exceed the spacing between the frames. The mesh should be progressively and smoothly refined to capture structural details where important or found necessary.

iv) At least three elements are to be used, where practical, to model webs of primary supporting members such as girders, transverses, stringers and floors. Rod elements may be used to model flanges of primary supporting members and brackets. The cross sectional area of rods representing sniped or tapered flanges is to be considered proportionally using an average area over the length of the element.

v) The aspect ratio of plate elements, in general, is not to exceed three. The use of triangular plate elements is to be kept to a minimum.

vi) Shell elements are to be used for plate elements subjected to lateral loading.

5 Strength Assessment

5.1 Loads and Loading Conditions

The loads and the loading conditions as specified in Section 3-2-1/1 and 3-2-2/1 of these Rules are to be considered for the longitudinal and transverse strength assessment, respectively. In addition, any loading condition that is included in the Loading Manual, which may overstress the dry dock during normal operations, is to be considered.

5.3 Extent of the FE Model

In general, a coarse mesh 3D finite element model to cover the entire dry dock structure is to be considered.

Where the scantlings, structural arrangement, loads, and loading pattern are identical/repetitive over the compartments (compartment here being structure between the two successive main WT BHDs of the pontoon structure), a model equivalent to three (3) compartments may be considered. Full breadth and depth of the dry dock is to be considered. The result of the middle compartment is to be applied over the entire length of the dry dock.

5.5 Boundary Conditions

5.5.1 General

In the state of static equilibrium, the free body of the hull girder is subjected to bending and torsional moments, as well as shear forces at two ends. These end actions are expressed as normal and shearing stresses on the hull girder and as boundary nodal forces imposed on the model. Even though the local and boundary loads are in equilibrium, the finite element model still needs some support in order to be statically stable. These supports are arranged in the way thereby minimizing the effects on the hull girder vertical, horizontal, and torsional bending moments' distribution on the model.

All boundary conditions described in this Subsection are in accordance with the global co-ordinate system defined below:

- X Axis: Along the length of the dry dock (positive fwd.)
- Y Axis: Along the depth of the dry dock (positive towards top deck from baseline)
- Z Axis: Along the breadth of the dry dock (positive towards STBD from centerline)

The six degrees of freedom for the nodes are defined with respect to the Cartesian global X, Y, and Z axes of the 3D finite element model, as u_x, u_y, andu_z for the three translational degrees of freedom, and θ_x, θ_y, and θ_z for the three rotational degrees of freedom.

The boundary conditions to be applied at the ends of the FE model are given in 3-2-A1/Table 2. The analysis is to be carried out by applying all loads to the model as a complete load case or by combining the stress responses resulting from several separate sub-cases.

FIGURE 1
Spring Constraints at Model Ends *(2018)*

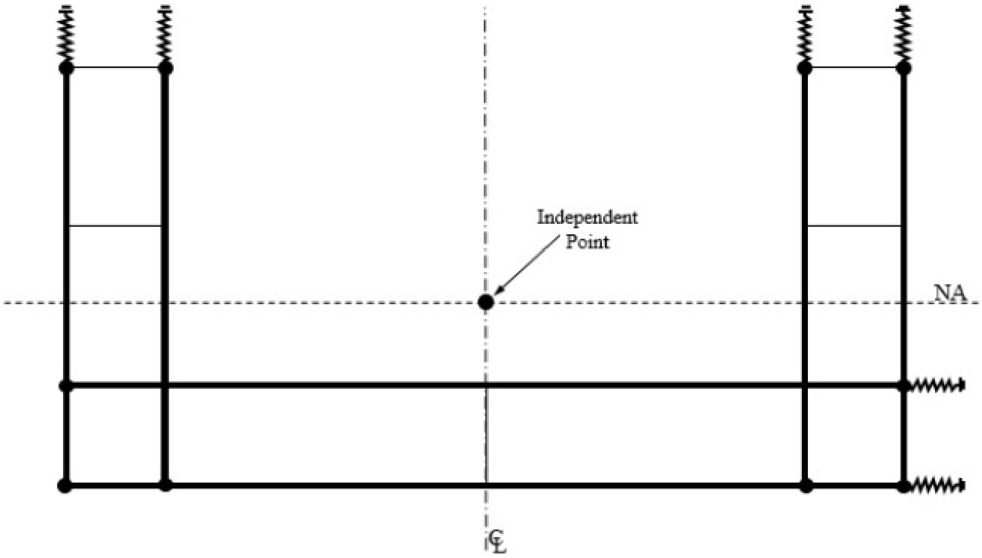

TABLE 2
Boundary Constraints at Model Ends *(2018)*

Location	*Translation*			*Rotation*		
	δ_x	δ_y	δ_z	θ_x	θ_y	θ_z
Aft End						
Aft end (all longitudinally effective elements)	RL	-	-	-	RL	RL
Independent point aft end, see 3-2-A1/ Figure 1	Fix	-	-	-	M_{h-end}	M_{v-end}
Pontoon deck, bottom	-	Springs	-	-	-	-
Side, inner skin	-	-	Springs	-	-	-
Fore End						
Fore end (all longitudinally effective elements)	RL	-	-	-	RL	RL
Independent point fore end, see 3-2-A1/ Figure 1	-	-	-	-	M_{h-end}	M_{v-end}
Pontoon deck, bottom	-	Springs	-	-	-	-
Side, inner skin	-	-	Springs	-	-	-

where

--- No constraint applied (free)

RL Nodal points of all longitudinally effective elements rigidly linked to independent point at neutral axis on centerline

Notes:

1; Where M_{h-end} is not applied, the independent points at the fore and aft ends are to be free in θ_y.

2; Where M_{v-end} is not applied, the independent points at the fore and aft ends are to be free in θ_z.

3; Where no bending moment is applied, the independent points at the fore and aft ends are to be free in θ_y and θ_z.

4; Where bending moment is applied as nodal forces, the independent points at the fore and aft endsare to be free in the corresponding degree of freedom rotations (i.e., θ_y and/or θ_z).

5.5.2 Supporting Rod and Its Property

Since forces and moments in the hull girder structures are not always completely balanced, it is recommended that special boundary supports be applied using rod elements in both the vertical and horizontal directions. These supports should have one end connected to the model and the other end totally fixed.

The cross sectional area of the supporting rod elements is calculated as follows:

$$A = \left(\frac{1}{1+v}\right)\frac{A_s l}{L} = 0.77 \quad \frac{A_s l}{L}$$

where

A	=	cross-sectional area of the supporting rod element
v	=	Poisson’s ration of the material
A_s	=	shearing area of the entire cross sectional area of the member underconsideration (i.e., plating of the shell, pontoon deck, bottom, etc.)
L	=	compartment length (compartment as defined in Section 3-2-A1/5.3)
l	=	length of the supporting rod element

The rod area A is determined by a given bar length l, which can be any value. In practice, however, all values of l in the finite element model are conveniently chosen to be the same round figure, for example, equal to 100 cm.

When the cross-section of the dry dock is idealized as a 2D frame, the above boundary condition may still be used in evaluating the stresses. However, additional stiffness in the form of springs to take care of the effect of the structure along the length to be included. Documentation including the spring stiffness calculation to be included in the report for review.

7 Acceptance Criteria

Permissible stresses as per Section 3-2-2/3 are to be considered for static loadings. For inclusion of dynamic loadings (dry dock on tow condition) and for the 3D FEA, the stresses are not to exceed the limits specified in 3-2-A1/Table 3.

TABLE 3
Acceptance Criteria *(2018)*

For 2D Analysis	
For static loadings	
Axial or bending stress in transverse members	$0.6F_y$

Shear Stress in transverse members	$0.4F_y$
For combined static and dynamic loadings	
Axial or bending stress in transverse members	$0.8F_y$
Shear Stress in transverse members	$0.53F_y$
For 3D FE Analysis	
For static loadings	
Von Mises Stress	$0.7S_mF_y$
For combined static and dynamic loadings	
Von Mises Stress	$0.90S_mF_y$

where

S_m = 1.0 for Mild Steel

= 0.95 for HT 32

= 0.908 for HT 36

F_y = Specified Min. Yield Strength of the Material

Notes:

1; Stress limits greater than $1.00S_mF_y$ in way of elements where boundary condition is applied are to be restricted to small areas and in way of structural discontinuities. A plot showing the elements with stress limits greater than specified above is to be submitted for review.

2; The above mentioned criteria limits for 3D FEA are applicable for coarse mesh (mesh size of one (1) stiffener spacing) FE model. When a mesh size finer than above is used in the assessment, stress limit may be increased accordingly subject to ABS' confirmation on the criteria. In no case, is the maximum permissible criteria to exceed $1.12S_mF_y$ for a mesh size of ~1/5 Stiffener Spacing.

3; For longitudinally effective structure that is modeled without the hull girder loads, the allowable stresses are to be decreased by 10%.

9 Buckling Strength

Buckling strength is to be adequate for the critical locations and high stressed areas subject to compressiveand /or shear stresses.

The buckling strength of such locations/areas is to comply with the latest version of the ABS *Guide for Buckling and Ultimate Strength Assessment for Offshore Structures,* or other recognized standard acceptable to ABS.

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CHAPTER 3 Stability

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CHAPTER 3 Stability

SECTION 1 General Requirements

1 General

Transverse stability calculations for the dry dock in the various operating conditions are to be submitted. The conditions to be considered are to include that of the dry dock loaded, with the top of the keel blocks breaking water, with the top of the pontoon at water level and other conditions that may be critical from initial ship touchdown to normal operating conditions. Longitudinal stability is also to be considered.

3 Transverse Stability

In general, the transverse GM of the combined ship and dry dock unit, after all free surface corrections are made for spaces in the dry dock, is not to be less than 1.525 m (5.0 ft) for dry docks with a rated lifting capacity of up to 10,200 metric tons (10,000 long tons). This transverse GM may be reduced linearly for rated capacities over 10,200 metric tons (10,000 long tons) to a minimum of 1.0 m (3.28 ft) for a rated lifting capacity of 51,000 metric tons (50,000 long tons) and above.

The operating manual for the dry dock is to include, preferably in the form of curves, data giving a range of ship weights and the associated ship centers of gravity that would result in the dry dock complying with the foregoing stability standards. In general, the foregoing transverse GM values are minimum. However, consideration of the operational environment may require an increase.

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CHAPTER 3 Stability

SECTION 2 Freeboard

1 General

The following freeboards are considered suitable for dry docks operating in sheltered waters. Where the operating site is not in sheltered waters, the freeboards are to be specially considered.

3 Wing Wall Freeboard

When the dry dock is submerged to its maximum draft, the wing wall freeboard is the least distance from the upper surface of the top deck to the waterline and is generally to be not less than 1.0 m (3.28 ft), provided the wing walls are watertight to the top deck.

5 Pontoon Freeboard

5.1 Rated Pontoon Freeboard

When the dry dock is supporting a ship of weight equal to the rated lifting capacity of the dock, the rated pontoon freeboard is the least distance from the waterline to the upper surface of the pontoon top plating. The rated freeboard is to be not less than 300 mm (12 in.).

5.3 Minimum Pontoon Freeboard

When the dry dock is supporting a ship of weight equal to the maximum lifting capacity of the dry dock, the minimum pontoon freeboard is the least distance from the waterline to the upper surface of the pontoon top plating. The minimum freeboard is to be not less than 75 mm (3 in.).

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CHAPTER 4 Testing During Construction - Hull

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CHAPTER 4 Testing During Construction - Hull

SECTION 1 Tank, Immersion, and Inclining Tests

1 Tank Testing

All tanks, except those used for ballast, and cofferdams are to be separately tested by a head of water to the highest point to which the liquid will rise in service. Where the scantlings of a tank boundary are based on the maximum differential head in service, care is to be taken so that test heads do not exceed the design differential head. Ballast compartments are to be hose tested. The tests are to be carried out under simultaneous inspection of both sides of the plating. The water pressure in the hose is not to be less than 2.11 kg/cm^2 (30 psi). On submission of all necessary detail, air testing may be considered as an alternative to the foregoing.

3 Immersion Test

Tests are to be carried out on completion of the dry dock to determine the dry dock lightweight. The density of water in which the tests are made is to be noted.

5 Inclining Test

On completion of construction, the dry dock is to be inclined to determine the vertical center of gravity. Alternatively, consideration may be given to determining the vertical center of gravity of the dry dock by calculation.

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Machinery Installations

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CHAPTER 1 Classification of Machinery

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CHAPTER 1 Classification of Machinery

SECTION 1 General Provisions

1 General

These Rules set forth requirements for the construction and installation of equipment and systems for dry docks. It is not intended by these Rules to require a particular arrangement of machinery. Other arrangements which are considered to offer comparable levels of safety for the proper functioning of the dry dock may be accepted.

Except as provided herein, requirements for boilers, pressure vessels, auxiliary engines, electrical equipment, pumps, and piping systems are to be in general accordance with the ABS *Marine Vessel Rules*, as far as applicable. Consideration will be given to electrical equipment constructed in accordance with a national or international standard for industrial equipment.

3 Testing

3.1 Piping Systems

Piping systems are to be tested to one and one-half times the working pressure.

3.3 General Systems

In general, the machinery, pumps, piping, materials, electrical systems, and fire-extinguishing systems are to be tested in accordance with the applicable requirements of the ABS *Marine Vessel Rules*, but need not be inspected at the plant of the manufacturer. The manufacturer's guarantee will be accepted, subject to satisfactory performance witnessed by the Surveyor after installation.

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CHAPTER **1 Classification of Machinery**

SECTION **2 Piping Systems**

1 Dewatering and Flooding Systems

A fixed dewatering system is to be installed with pumps securely mounted on structural foundations and arranged to permit unrestricted flow to the pump suction. The arrangements for dewatering are to be such that in case of failure of the normal means an alternative means of pumping is available for each ballast tank. Each overboard discharge line is to have a positive-closing overboard discharge valve located adjacent to the shell of the dry dock and operable from above the safety deck (see 3-1-1/11). In addition, a non-return valve is to be provided inboard or outboard of the overboard discharge valve. Systems providing bypasses around pump and non-return valves to permit fast flooding will be subject to special consideration.

The arrangements for flooding are to be such that in the case of failure of the normal means an alternative means of flooding is available for each ballast tank. Cross flooding, if provided, is to be arranged so that adequate stability is maintained. Flooding valves are to be located as close as practicable to the shell of the dry dock or inlet sea chest. The inlet is to be protected by a bar type strainer.

Pump and valve shafts and extension drives located in the ballast tanks are to be of suitable corrosion resistant materials. Requirements for valves and piping systems are to be in general accordance with the ABS *Marine Vessel Rules*. However, the use of cast iron valves attached to the dry dock shell may be considered.

3 Venting Arrangements

Adequate venting is to be provided. Where air pipes are extended below decks to form an air cushion, they are to be of substantial thickness and also adequately supported at their lower ends.

5 Service Systems

When provided, connections to the dry dock for service systems including compressed air, salt water, fresh water, steam, oxygen, and natural and manufactured gases are to be permanently connected flexible hoses. Oxygen and acetylene lines are to have flashback arresters in the main and in all portable branches and are to have excess flow shut-off valves on the supply connection for the hoses. Piping for oxygen and acetylene is to be of seamless steel not less than American National Standards Institution (ANSI) schedule 40 or equivalent with all welded joints with brass valves for oxygen and diaphragm type for natural and manufactured gas, and fittings of ANSI 150 pound standard or equivalent.

7 Fire System

A water fire extinguishing system is to be provided for the protection of the dry dock and docked vessels. There is to be a branch of the fire main on each wing wall with fire hydrants on the top deck located not more than 30.5 m (100 ft) apart. The fire main is to have a capacity of 6.3 liters/sec (100 gpm) for every 30.5 m (100 ft) of length of the dry dock, except that this capacity is not to be less than 15.8 liters/sec (250 gpm) and is not required to be more than 47.3 liters/sec (750 gpm).

Two separate means of water supply are to be provided for the fire main. Where an adequate shoreside supply is not available, a fire pump is to be provided on the dry dock. Each means is to be capable of providing the above required flow of water at a pressure of not less than 8.8 kg/cm2 (125 psi) gauge in the fire main. However, consideration will be given to the use of pressure less than this where, with standard nozzle sizes of 12 mm (0.5 in.), 16 mm (0.625 in.) and 20 mm (0.75 in.), a pressure of 2.8 kg/cm2 (40 psi) can be maintained at all hydrants of the dry dock and largest docked vessel, while one of the means of water supply delivers the required capacity through adjacent hydrants.

Where operated in temperatures below 0°C (32°F), a means of draining the fire mains is to be provided. The fire main lines are to be located on or preferably just below the top deck. Provision is to be made for connecting a docked vessel fire system to the dry dock fire system. The interior spaces of the dry dock are to have portable fire extinguishers in general accordance with the ABS *Marine Vessel Rules*.

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CHAPTER 1 Classification of Machinery

SECTION 3 Electric Power and Lighting

1 General

All dry docks using electricity for power or lighting are to be provided with at least two sources of electric power. These sources may comprise:

- Feeders from shoreside utility power supply
- Electric generators installed on the dry dock
- A combination of the above

Other arrangements will be subject to special consideration.

3 Shoreside Utility Power Supply

Dry docks having electric power supplied from shoreside sources are to be provided with at least one main feeder and one standby feeder from the shipyard or public utility substation. The capacity of the main feeder is to be sufficient for operation of the dewatering pumps at stated capacities plus operation of the fire pump, if provided on the dry dock, operation of valves, communication system, alarms, and lighting. In addition, with the main feeder out of service, the capacity and arrangement of the standby feeder is to be such that the dry dock maintains use of the fire pump, valve operation, lighting, alarms, and communication system. Feeders to the dry dock are to be separated as far as practicable and are preferably to be run to each wing wall.

Feeder cables to the dry dock are to be fully insulated and suitable for flexing service. They are to enter the dry dock through watertight heads and up to the distribution center or unit substation they are to run in a steel conduit or are to be protected by cable trays or rigid wire nets.

5 Electric Generators Installed on the Dry Dock

As an alternative to 4-1-3/3, dry docks may have electric power supplied by generators located onboard the dry dock. In such arrangements, there are to be not less than two generators, the combined capacity of which is sufficient for operation of the dewatering pumps. In addition, with any one generator out of service, the capacity of the remaining generators is to be sufficient so that the dry dock maintains use of the valve operation, lighting, alarms, communication system, and fire pump, if provided on the dry dock.

7 Combined Electric Power Supply

Arrangements in which the normal electric power supply is from a shoreside substation and standby power is provided by a generator located on the dry dock, or in which the normal power is supplied by onboard generation with standby power from shoreside, will receive special consideration. Such installations are to be arranged to prevent paralleling of the electric power generated onboard with shoreside power supply. The standby source of power is to be sufficient for the dry dock to maintain use of the fire pump, if provided on the dry dock, valve operation, lighting, alarms, and communication system.

9 Emergency Service

Where both the main and standby sources of power are provided from the shipyard or from a public utility substation, a self-contained emergency source of power is to be provided. This emergency power is to operate automatically on failure of normal supply and is to have sufficient capacity to provide emergency lighting, alarms, and communication for a period of two hours.

11 Voltage

In general, the voltage for the electric power supply to the dry dock is not to exceed 15,000 volts. Higher voltages will be subject to special consideration.

13 Unit Substations

Where required by the design, unit substations are to be of the number and capacity required for shoreside feeders. Substations are to be located on the safety deck within the wing wall or as may otherwise be approved, and they are to be metal enclosed and drip-proof protected. Distribution sections are to be of the dead-front type.

15 Transformers

In general, transformers installed on the dry dock are to be of the dry type. The use of liquid filled transformers will be subject to special consideration. The design temperature rise of insulated windings, based on an ambient temperature of 40°C, is not to exceed the values in the following table:

Class of Insulation	*A*	*B*	*F*	*H*
Temperature Rise (°C)	55	80	115	150
Maximum Hot Spot Temperature Rise (°C)	65	110	145	180

Appropriate reductions are to be made in the table values where ambient temperatures are in excess of 40°C.

17 Service Disconnect Switch

A fused service disconnect switch or circuit breaker is to be provided for each feeder and is to be located ashore as close as practicable to the dry dock. This switch is to be capable of being safely opened under load or closed into a fault.

19 Switchgear

Feeder and distribution switchgear for shoreside power supply is to be of the metal enclosed or dead-front type. The following instruments are to be provided for each voltage level.

- Voltmeter
- Ammeter
- Ground fault indication

Switchgear is to be braced for maximum available fault current, and circuit breakers and fuses are to be capable of interrupting maximum fault current at their point of application. Fault current studies are to be submitted for approval and are to include determination of available feeder source current at the service disconnect switch.

21 Cables

Cables are to be constructed in accordance with a recognized standard and are to have water resistant insulation. In general, conductors are to be of copper. However, in sizes above No. 4 AWG (21 mm^2), special consideration will be given to the use of aluminum conductors. When aluminum conductors are proposed, terminations, connections, and other installation details will be subject to review and approval.

23 Lighting *(2019)*

Permanent lighting is to be on the top deck, wing walls, and in interior spaces as necessary for access and operation of the dry dock. Exterior and interior operating and control areas are to have the lighting arranged so that failure of one branch circuit will not leave these areas in darkness. Where lighting is installed in the wing walls, which is liable to submergence, the fixtures are to be watertight.

PART
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CHAPTER 1 Classification of Machinery

SECTION 4 Control and Communications SystemsConcept title

1 Control Systems

Controls and indicators are to be provided as necessary for the operation of the dry dock. Dewatering pumps are to have motor running indication. Flooding and discharge valves are to be provided with valve position indicators. Means are to be provided for determining the water level in each of the ballast compartments and the draft at each of the corners and at mid-length of the dry dock. When it is desired to fit a centralized control system with remote control of the flooding and dewatering systems, the arrangements and details of the system will be subject to approval.

3 Communications Systems

A public address system or other system of communication is to be provided between the control center, the centering station and both wing walls. A sound powered telephone or other communications system is also to be provided between the control center and each safety deck substation or motor control center to facilitate the operation of the dewatering pumps and the flooding and dewatering valves.