GUIDE FOR BUILDING AND CLASSING

INTERNATIONAL NAVAL SHIPS 2018

NOTICE NO. 1 – MARCH 2018

The following Rule Changes were approved by the ABS Rules Committee on 30 January 2018 and become **EFFECTIVE AS OF 1 MARCH 2018.**

(See http://www.eagle.org for the consolidated version of the Guide for Building and Classing International Naval Ships 2017, with all Notices and Corrigenda incorporated.)

Notes - *The date in the parentheses means the date that the Rule becomes effective for new construction based on the contract date for construction, unless otherwise noted. (See 1-1-4/3.3 of the ABS Rules for Conditions of Classification (Part 1).)*

PART 3 HULL CONSTRUCTION AND EQUIPMENT

CHAPTER 3 SUBDIVISION AND STABILITY

SECTION 1 GENERAL REQUIREMENTS

(Revise Subsection 3-3-1/1, as follows:)

1 General *(1 March 2018)*

All vessels are to demonstrate that they have adequate subdivision and stability for the intended service.

The stability of each vessel is to be evaluated for all loading conditions indicated in 3-3-1/15, verifying compliance with the intact and damage stability criteria in Appendix 3-3-A1 and taking into account the design considerations indicated in 3-3-1/15, and the results are to be submitted for review.

When appropriate, such as for vessels that lift heavy weights on or off the vessel stern or other operations that could affect longitudinal stability, the longitudinal intact stability of the loading conditions is also to be investigated.

The maximum allowable KG (or minimum required GM) curve shall confirm compliance with the intact and damage criteria in Appendix 3-3-A1. This curve (or series of curves) shall cover the full range of operation (Load Line/maximum draft to arrival condition, and the full range of anticipated trims). The supporting calculations for this curve shall be submitted for review.

Compliance with a subdivision and stability standard that may be specified by the Naval Administration (e.g., the Naval Ship Code) is considered an acceptable alternative to meeting the requirements in this Chapter, subject to such standards being determined by ABS as being not less effective than the Rules.

(Paragraphs 3-3-1/1.1 and 3-3-1/1.3 are unchanged.)

(Add new Part 6, Chapter 3, as follows:)

PART 6 OPTIONAL NOTATIONS

CHAPTER 3 HULL GIRDER ULTIMATE STRENGTH ASSESSMENT *(2018)*

SECTION 1 GENERAL

1 Application

This Section establishes the requirement for the optional notation **UHS**.

The requirements are applicable to the hull structure within 0.4*L* amidships in sea-going conditions. If the structure of the vessel complies with the requirements in this chapter and Sections 3-2-1 to 3-2-11, it will be classed and distinguished in the *Record* by the notation **UHS** placed after the appropriate hull classification notation.

PART 6 OPTIONAL NOTATIONS

CHAPTER 3 HULL GIRDER ULTIMATE STRENGTH ASSESSMENT

SECTION 2 CHECKING CRITERIA

1 Vertical Hull Girder Ultimate Limit State

The vertical hull girder bending moments are to satisfy the following limit state:

$$\gamma_S M_{sw} + \gamma_W M_w \le \frac{M_U}{\gamma_R}$$

where

M_{sw}	=	still water bending moment, in kN-m (tf-m), in accordance with 3-2-1/3.3
M_w	=	maximum wave-induced vertical bending moment, in kN-m (tf-m), in accordance with 3-2-1/3.3.3(a)
M_U	=	vertical hull girder ultimate bending capacity, in kN-m (tf-m), as defined in 6-3-2/3
γ_S	=	1.0 partial safety factor for the still water bending moment
γ_w	=	partial safety factor for the vertical wave bending moment taking into account environmental and wave load prediction uncertainties
		1.3 for hogging wave bending moment
		1.5 for sagging wave bending moment
γ_R	=	1.10 partial safety factor for the vertical hull girder bending capacity covering material, geometric and strength prediction uncertainties

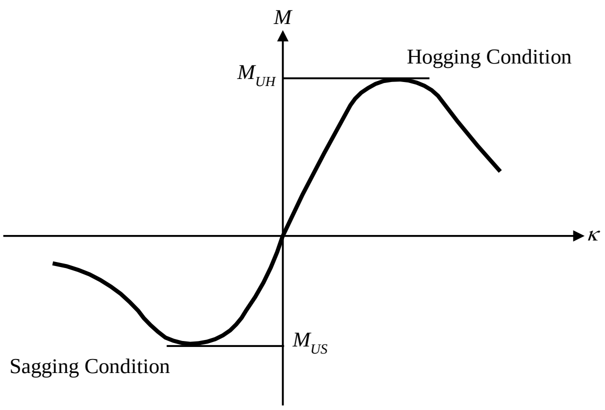
For vessels where the vertical hull girder bending capacity is evaluated with gross scantlings, γ_R is to be taken as 1.25.

3 Hull Girder Ultimate Bending Capacity

3.1 General

The ultimate bending moment capacities of a hull girder section in hogging and sagging conditions are defined as the maximum values (positive M_{UH}, negative M_{US}) on the static nonlinear bending moment-curvature relationship M-κ. See 6-3-2/Figure 1. The curve represents the progressive change and collapse behavior of the hull girder under vertical bending moments. Hull girder failure is controlled by buckling, ultimate strength and yielding of longitudinal hull girder structural elements.

FIGURE 1
Bending Moment – Curvature Curve M-κ *(1 March 2018)*



The curvature of the critical inter-frame section, κ, is defined as:

$$\kappa = \frac{\theta}{\ell} \text{ m}^{-1}$$

where:

θ	=	relative angle rotation of the two neighboring cross-sections at transverse frame positions
ℓ	=	transverse frame spacing in m, (i.e., span of longitudinals)

The calculation of the hull girder ultimate bending capacity is found by identifying the critical failure modes of all hull girder structural elements.

Hull girder structural members compressed beyond their buckling limit have reduced load carrying capacity. All relevant failure modes for individual structural elements are to be considered in order to identify the weakest inter-frame failure mode. Examples of relevant failure modes are plate buckling, torsional stiffener buckling, stiffener web buckling, lateral or global stiffener buckling, and their interactions,

The effects of shear force, torsional loading, horizontal bending moment and lateral pressure are neglected.

3.3 Physical Parameters

For the purpose of describing the calculation procedure in a concise manner, the physical parameters and units used in the calculation procedure are given below.

3.3.1 Hull Girder Load and Cross Section Properties

M_i = hull girder bending moment, in kN-m (tf-m)

F_i = hull girder longitudinal force, in kN (tf)

I_v = hull girder moment of inertia around the horizontal neutral axis of intact section, in m^4

SM = hull girder section modulus, in m^3

SM_{dk} = elastic hull girder section modulus at deck at side, in m^3

SM_{kl} = elastic hull girder section modulus at bottom, in m^3

κ = curvature of the ship cross section, in m^{-1}

z_j = distance from baseline, in m

3.3.2 Material Properties

σ_{yd} = specified minimum yield stress of the material, in N/cm^2 (kgf/cm^2)

E = Young's modulus for steel, 2.06×10^7 N/cm^2 (2.1×10^6 kgf/cm^2)

ν = Poisson's ratio, may be taken as 0.3 for steel

Φ = edge function as defined in 6-3-2/3.9.2

ε = relative strain defined in 6-3-2/3.9.2

3.3.3 Stiffener Sectional Properties

The properties of a longitudinal cross section are shown in 6-3-2/Figure 2.

A_s = sectional area of the longitudinal or stiffener, excluding the associated plating, in cm^2

b_1 = smaller outstanding dimension of flange with respect to centerline of web, in cm

b_f = total width of the flange/face plate, in cm

d_w = depth of the web, in cm

t_p = net thickness of the plating, in cm

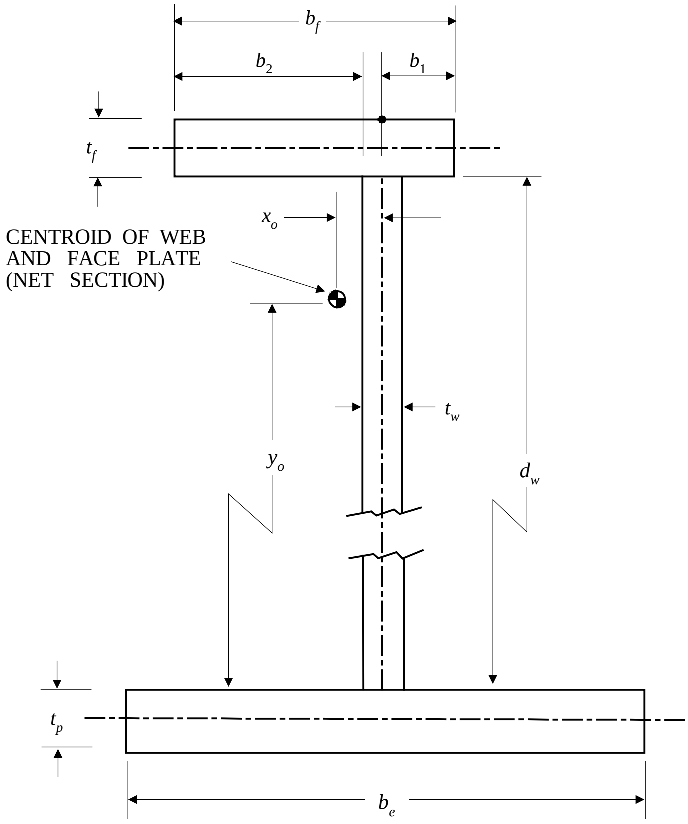
t_f = net thickness of the flange/face plate, in cm

t_w = net thickness of the web, in cm

x_o = distance between centroid of the stiffener and centerline of the web plate, in cm

y_o = distance between the centroid of the stiffener and the attached plate, in cm

FIGURE 2
Dimensions and Properties of Stiffeners *(1 March 2018)*



3.5 Calculation Procedure

The hull girder ultimate bending capacity M_U (M_{UH} or M_{US}) is defined as the peak value of the curve with vertical bending moment M versus the curvature κ of the ship cross section as shown in 6-3-2/Figure 1.

The curve M-κ is obtained by means of an incremental-iterative approach. The steps involved in the procedure are given below.

The bending moment M_i which acts on the hull girder transverse section due to the imposed curvature κ_i is calculated for each step of the incremental procedure. This imposed curvature corresponds to an angle of rotation of the hull girder transverse section about its effective horizontal neutral axis, which induces an axial strain ε in each hull structural element.

The stress σ induced in each structural element by the strain ε is obtained from the stress-strain curve σ-ε of the element, which takes into account the behavior of the structural element in the nonlinear elasto-plastic domain.

The force in each structural element is obtained from its area times the stress and these forces are summed to derive the total axial force on the transverse section. Note the element area is taken as the total net area of the structural element. This total force may not be zero as the effective neutral axis may have moved due to the nonlinear response. Hence, it is necessary to adjust the neutral axis position, recalculate the element strains, forces and total sectional force, and iterate until the total force is zero.

Once the position of the new neutral axis is known, the correct stress distribution in the structural elements can be obtained. The bending moment M_i about the new neutral axis (due to the imposed curvature κ_i) is then obtained by summing the moment contribution given by the force in each structural element.

The main steps of the incremental-iterative approach are summarized as follows:

Step 1 Divide the hull girder transverse section into structural elements, (i.e., longitudinal stiffened panels (one stiffener per element), hard corners and transversely stiffened panels). See 6-3-2/3.7.

Step 2 Derive the stress-strain curves (also known as the load-end shortening curves) for all structural elements. See 6-3-2/3.9.

Step 3 Determine the curvature step size $\Delta\kappa$:

$$\Delta\kappa = \frac{\max\left(SM_{dk}\sigma_{yd}, SM_{kl}\sigma_{yd}\right)}{100EI_v}$$

The curvature for the first step $\kappa 1$ is to be taken as $\Delta\kappa$.

Derive the neutral axis $z_{NA\text{-}i}$ for the first incremental step (i = 1) with the value of the elastic hull girder section modulus. See 3-2-1/9.

Step 4 For each element (index j), calculate the strain $\varepsilon_{ij} = \kappa_i(z_j - z_{NA\text{-}i})$ corresponding to κ_i, the corresponding stress σ_j, and hence the force in the element $\sigma_j A_j$. The stress σ_j corresponding to the element strain ε_{ij} is to be taken as the minimum stress value from all applicable stress-strain curves σ-ε for that element.

Step 5 Determine the new neutral axis position $z_{NA\text{-}i}$ by checking the longitudinal force equilibrium over the whole transverse section. Hence, adjust $z_{NA\text{-}i}$ until:

$$F_i = 10^{-3}\ \Delta A_j \sigma_j = 0$$

Note σ_j is positive for elements under compression and negative for elements under tension. Repeat from Step 4 until equilibrium is satisfied. Equilibrium is satisfied when the change in neutral axis position is less than 0.0001 m.

Step 6 Calculate the corresponding moment by summing the force contributions of all elements as follows:

$$M_i = 10^{-3} \sum \sigma_j A_j \left|\left(z_j - z_{NA-i}\right)\right|$$

Step 7 Increase the curvature by $\Delta\kappa$, use the current neutral axis position as the initial value for the next curvature increment and repeat from Step 4 until the peak value Mu occurs on the M-κ curve. The ultimate capacity is the peak value M_u from the M-κ curve.

3.7 Assumptions and Modeling of the Hull Girder Cross-section

In applying the procedure described in this Chapter, the following assumptions are to be made:

i) The ultimate strength is calculated at a hull girder transverse section between two adjacent transverse webs.

ii) The hull girder transverse section remains plane during each curvature increment.

iii) The material properties of steel are assumed to be elastic and perfectly plastic.

iv) The hull girder transverse section can be divided into a set of elements which act independently of each other.

v) The elements making up the hull girder transverse section are:

- Longitudinal stiffeners with attached plating, with structural behavior given in 6-3-2/3.9.2 through 6-3-2/3.9.6
- Transversely stiffened plate panels, with structural behavior given in 6-3-2/3.9.7
- Hard corners, as defined below, with structural behavior given in 6-3-2/3.9.1

vi) The following structural areas are to be defined as hard corners:

- The plating area adjacent to intersecting plates
- The plating area adjacent to knuckles in the plating with an angle greater than 30 degrees
- Plating comprising rounded gunwales

An illustration of hard corner definition for girders on longitudinal bulkheads is given in 6-3-2/Figure 3.

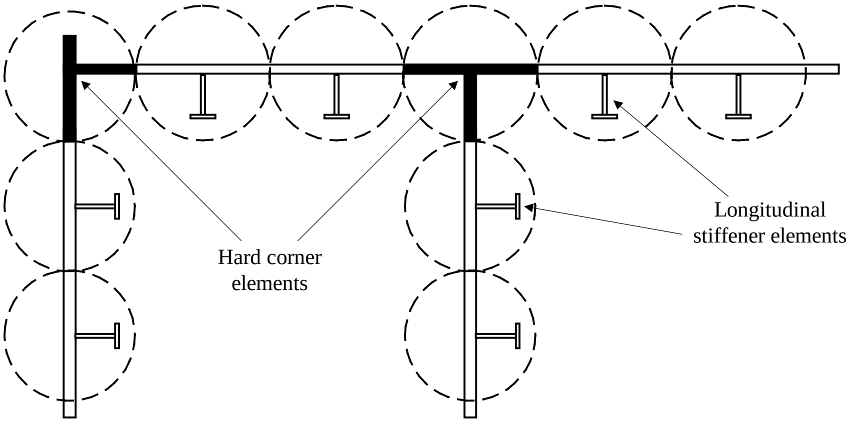
vii) The size and modeling of hard corner elements is to be as follows:

- It is to be assumed that the hard corner extends up to *s*/2 from the plate intersection for longitudinally stiffened plate, where *s* is the stiffener spacing
- It is to be assumed that the hard corner extends up to $20t_{grs}$ from the plate intersection for transversely stiffened plates, where t_{grs} is the gross plate thickness

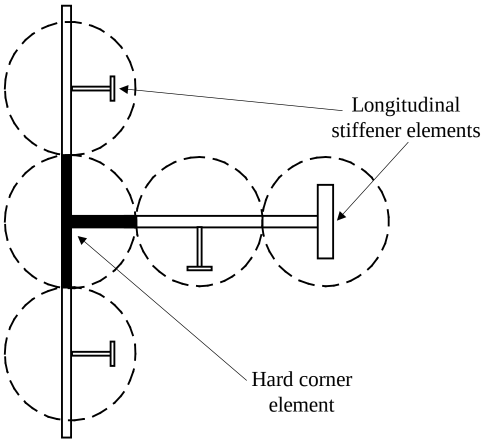
Note: For transversely stiffened plate, the effective breadth of plate for the load shortening portion of the stress-strain curve is to be taken as the full plate breadth (i.e., to the intersection of other plates – not from the end of the hard corner). The area is to be calculated using the breadth between the intersecting plates.

FIGURE 3
Example of Defining Structural Elements *(1 March 2018)*

a) Example showing side shell, inner side and deck



b) Example showing girder on longitudinal bulkhead



3.9 Stress-strain Curves σ-ε (or Load-end Shortening Curves)

3.9.1 Hard Corners

Hard corners are sturdier elements which are assumed to buckle and fail in an elastic, perfectly plastic manner. The relevant stress strain curve σ-ε is to be obtained for lengthened and shortened hard corners according to 6-3-2/3.9.2.

3.9.2 Elasto-Plastic Failure of Structural Elements

The equation describing the stress-strain curve σ-ε of the elasto-plastic failure of structural elements is to be obtained from the following formula, valid for both lengthened and shortened hard corners (6-3-2/Figure 4A) and lengthened stiffeners (6-3-2/Figure 4B):

$$\sigma = \Phi\, \sigma_{yd} \quad \text{kN/cm}^2\ (\text{kgf/cm}^2)$$

where

Φ = edge function

= -1 for $\varepsilon < -1$

= ε for $-1 < \varepsilon < 1$

= 1 for $\varepsilon > 1$

ε = relative strain

= $\dfrac{\varepsilon_E}{\varepsilon_{yd}}$

ε_E = element strain

ε_{yd} = strain corresponding to yield stress in the element

= $\dfrac{\sigma_{yd}}{E}$

Note: The signs of the stresses and strains in this Section are opposite to those in the rest of the Rules.

FIGURE 4A
Example of Stress Strain Curves σ-ε *(1 March 2018)*

Stress strain curve σ-ε for elastic, perfectly plastic failure of a hard corner

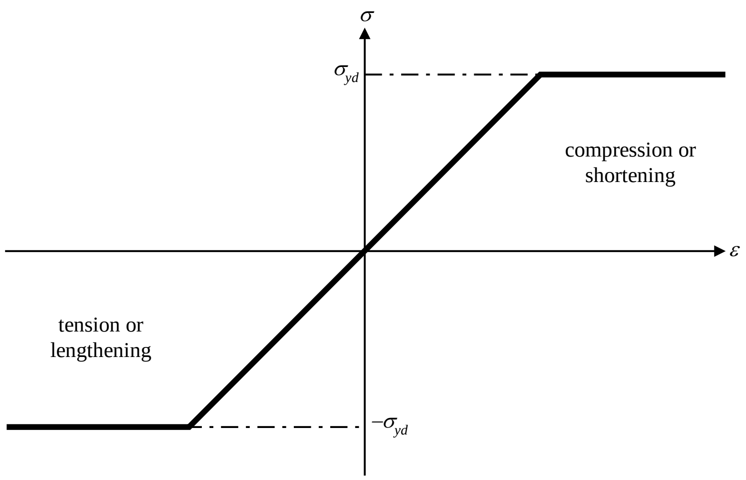
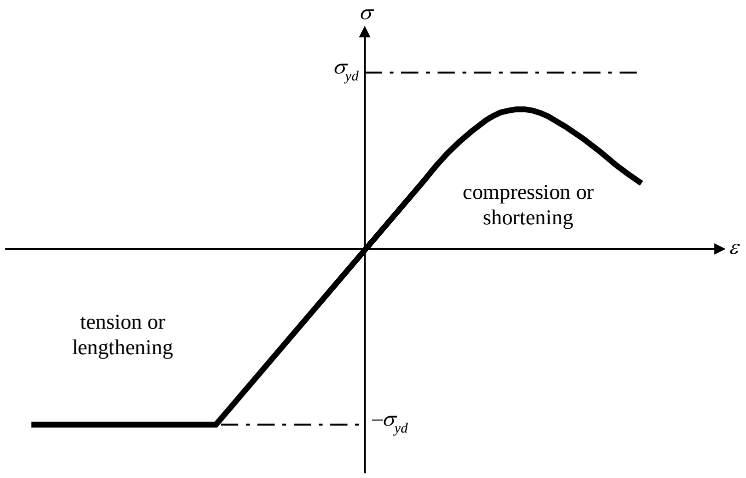


FIGURE 4B
Example of Stress Strain Curves σ-ε *(1 March 2018)*

Typical stress strain curve σ-ε for elasto-plastic failure of a stiffener



3.9.3 Beam Column Buckling

The equation describing the shortening portion of the stress strain curve σ_{CR1}-ε for the beam column buckling of stiffeners is to be obtained from the following formula:

$$\sigma_{CR1} = \Phi\sigma_{C1}\left(\frac{A_s + b_{eff-p}t_p}{A_s + st_p}\right) \quad \text{kN/cm}^2 \text{ (kgf/cm}^2\text{)}$$

where

σ_{C1} = critical stress, in kgf/cm^2 (kgf/cm^2)

= $\dfrac{\sigma_{E1}}{\varepsilon}$ for $\sigma_{E1} \le \dfrac{\sigma_{yd}}{2}\varepsilon$

= $\sigma_{yd}\left(1 - \dfrac{\sigma_{yd}\varepsilon}{4\sigma_{E1}}\right)$ for $\sigma_{E1} > \dfrac{\sigma_{yd}}{2}\varepsilon$

σ_{E1} = Euler column buckling stress, in kgf/cm^2 (kgf/cm^2)

= $\pi^2 E \dfrac{I_E}{A_E \ell^2}$

ℓ = unsupported span of the longitudinal, in cm

s = plate breadth taken as the spacing between the stiffeners, in cm

I_E = net moment of inertia of stiffeners, in cm^4, with attached plating of width b_{eff-s}

b_{eff-s} = effective width, in cm, of the attached plating for the stiffener

= $\dfrac{s}{\beta_p}$ for $\beta_p > 1.0$

= s for $\beta_p \le 1.0$

β_p = $\dfrac{s}{t_p}\sqrt{\dfrac{\varepsilon\sigma_{yd}}{E}}$

A_E = net area of stiffeners, in cm^2, with attached plating of width $b_{eff\text{-}p}$

$b_{eff\text{-}p}$ = effective width, in cm, of the plating

= $\left(\dfrac{2.25}{\beta_p} - \dfrac{1.25}{\beta_p^2}\right)s$ for $\beta_p > 1.25$

= s for $\beta_p \leq 1.25$

3.9.4 Torsional Buckling of Stiffeners

The equation describing the shortening portion of the stress-strain curve σ_{CR2}-ε for the lateral-flexural buckling of stiffeners is to be obtained according to the following formula:

$$\sigma_{CR2} = \Phi\left(\frac{A_s\sigma_{C2} + st_p\sigma_{CP}}{A_s + st_p}\right) \quad \text{kN/cm}^2 \text{ (kgf/cm}^2\text{)}$$

where

σ_{C2} = critical stress

= $\dfrac{\sigma_{E2}}{\varepsilon}$ for $\sigma_{E2} \leq \dfrac{\sigma_{yd}}{2}\varepsilon$

= $\sigma_{yd}\left(1 - \dfrac{\sigma_{yd}\varepsilon}{4\sigma_{E2}}\right)$ for $\sigma_{E2} > \dfrac{\sigma_{yd}}{2}\varepsilon$

σ_{CP} = ultimate strength of the attached plating for the stiffener

= $\left(\dfrac{2.25}{\beta_p} - \dfrac{1.25}{\beta_p^2}\right)\sigma_{yd}$ for $\beta_p > 1.25$

= σ_{yd} for $\beta_p \leq 1.25$

β_p = coefficient defined in 6-3-2/3.9.3

σ_{E2} = Euler torsional buckling stress, in kN/cm^2 (kgf/cm^2), equal to reference stress for torsional buckling σ_{ET}

σ_{ET} = $E[K/2.6 + (n\pi/\ell)^2\Gamma + C_o(\ell/n\pi)^2/E]/I_o[1 + C_o(\ell/n\pi)^2/I_o f_{cL}]$

K = St. Venant torsion constant for the longitudinal's cross section, excluding the associated plating

= $\left[b_f t_f^3 + d_w t_w^3\right]/3$

I_o = polar moment of inertia of the longitudinal, excluding the associated plating, about the toe (intersection of web and plating)

= $I_x + mI_y + A_s\left(x_o^2 + y_o^2\right)$ in cm^4

I_x, I_y = moment of inertia of the longitudinal about the x- and y-axis, respectively, through the centroid of the longitudinal, excluding the plating (x-axis perpendicular to the web), in cm^4

m = $1.0 - u(0.7 - 0.1d_w/b_f)$

u	=	asymmetry factor
	=	$1 - 2b_1/b_f$
C_o	=	$E\,t_p^3/3s$
Γ	=	warping constant
	≅	$mI_{yf}\,d_w^2 + d_w^3\,t_w^3/36$
I_{yf}	=	$t_f\,b_f^3\,(1.0 + 3.0\,u^2 d_w t_w/A_s)/12$
f_{cL}	=	critical buckling stress for the associated plating, corresponding to n-half waves
	=	$\pi^2 E(n/\alpha + \alpha/n)^2(t_p/s)^2/12(1 - \nu^2)$
α	=	ℓ/s
ℓ	=	unsupported span of the longitudinal, in cm
s	=	plate breadth taken as the spacing between the stiffeners, in cm
n	=	number of half-wave which yield a smallest σ_{ET}

3.9.5 Web Local Buckling of Stiffeners with Flanged Profiles

The equation describing the shortening portion of the stress strain curve σ_{CR3}-ε for the web local buckling of flanged stiffeners is to be obtained from the following formula:

$$\sigma_{CR3} = \Phi\sigma_{yd}\left(\frac{b_{eff-p}t_p + d_{w-eff}t_w + b_f t_f}{st_p + d_w t_w + b_f t_f}\right) \quad \text{kN/cm}^2\ (\text{kgf/cm}^2)$$

where

s	=	plate breadth taken as the spacing between the stiffeners, in cm
$b_{eff\text{-}p}$	=	effective width of the attached plating in cm, defined in 6-3-2/3.9.3
$d_{w\text{-}eff}$	=	effective depth of the web, in cm
	=	$\left(\frac{2.25}{\beta_w} - \frac{1.25}{\beta_w^2}\right)d_w$ for $\beta_w > 1.25$
	=	d_w for $\beta_w \le 1.25$
β_w	=	$\frac{d_w}{t_w}\sqrt{\frac{\varepsilon\sigma_{yd}}{E}}$

3.9.6 Local Buckling of Flat Bar Stiffeners

The equation describing the shortening portion of the stress-strain curve σ_{CR4}-ε for the web local buckling of flat bar stiffeners is to be obtained from the following formula:

$$\sigma_{CR4} = \Phi\left(\frac{A_s\sigma_{C4} + st_p\sigma_{CP}}{A_s + st_p}\right) \quad \text{kN/cm}^2\ (\text{kgf/cm}^2)$$

where

σ_{CP}	=	ultimate strength of the attached plating, in kN/cm^2 (kgf/cm^2)

σ_{C4} = critical stress, in kN/cm^2 (kgf/cm^2)

$$= \frac{\sigma_{E4}}{\varepsilon} \quad \text{for } \sigma_{E4} \le \frac{\sigma_{yd}}{2}\varepsilon$$

$$= \sigma_{yd}\left(1 - \frac{\sigma_{yd}\varepsilon}{4\sigma_{E4}}\right) \quad \text{for } \sigma_{E4} > \frac{\sigma_{yd}}{2}\varepsilon$$

σ_{E4} = Euler buckling stress

$$= \frac{0.44\pi^2 E}{12(1-\nu^2)}\left(\frac{t_w}{d_w}\right)^2$$

3.9.7 Buckling of Transversely Stiffened Plate Panels

The equation describing the shortening portion of the stress-strain curve σ_{CR5}-ε for the buckling of transversely stiffened panels is to be obtained from the following formula:

$$\sigma_{CR5} = \min\begin{cases}\sigma_{yd}\left[\dfrac{s}{\ell_{stf}}\left(\dfrac{2.25}{\beta_p} - \dfrac{1.25}{\beta_p^2}\right) + 0.115\left(1 - \dfrac{s}{\ell_{stf}}\right)\left(1 + \dfrac{1}{\beta_p^2}\right)^2\right] \\ \sigma_{yd}\Phi\end{cases} \quad \text{kN/cm}^2 \text{ (kgf/cm}^2\text{)}$$

where

β_p = coefficient defined in 6-3-2/3.9.3

s = plate breadth taken as the spacing between the stiffeners, in cm

ℓ_{stf} = span of stiffener equal to spacing between primary support members, in cm

(Add new Part 6, Chapter 4, as follows:)

PART 6 OPTIONAL NOTATIONS

CHAPTER 4 NAVAL SHIP SAFETY CERTIFICATE

SECTION 1 GENERAL

1 Application

The Naval Ship Safety Certificate and **NavalSafe(x)** notation are issued based on compliance with The Naval Ship Code (NSC). The NSC is published by the North Atlantic Treaty Organization (NATO) as ANEP (Allied Naval Engineering Publication) 77, and is approved by the nations in the NATO Naval Armaments Group. It is a non-classified document intended to address naval surface ship safety and is based on IMO conventions, resolutions and other sources.

The Code is applicable to all surface craft used for non-commercial government service, such as Navy, Coast Guard, Border Patrol, and Customs. It applies principally to conventionally powered, non-nuclear ships.

When applying the Code, consideration is to be given to determine how the ship will continue to be verified to the Code for recertification during its service operation, in order to avoid unintended safety degradation due to modifications or modernization measures applied to the ship over its life.

The Code requires that a Concept of Operations Statement (or ConOpS) be developed to compare the applicability of the criteria and standards chosen. The ConOpS may change over the service life of a government ship, perhaps several times. Criteria may need to be reconsidered over the life of the ship as the ConOpS evolves. Once this is determined, the Code can provide a path for a ship to be certified by a Naval Administration, along with recognized organizations (RO) such as classification societies, to establish that a ship complies with the design and construction aspects of the code to operate in accordance with the ConOpS provided, as well as within the safety policies, and safety organization, of the government organization in which it will operate.

While the goal-based nature of the Code allows the Naval Administration and ROs to consider alternatives to the typical safety requirements applied to commercial ships, it is important to emphasize two limitations:

1. The Naval Ship Code is not intended as a complete and all inclusive safety management system for a ship or fleet. It is, rather, a tool for the safe operation for a ship or fleet, and may fill an important role in the fleet or administration's safety policy.

2. It includes processes and potential solutions for the defined technical areas which can be applied to any naval ship, within the context of its operational requirements. While fully intended to apply to operating conditions and foreseeable damage scenarios applicable to peacetime and maritime security (as determined in the ConOpS), the Code is not intended to apply to combat operations, or its associated threat conditions. While an important part of a government operated ship intended for military or defense related operations, these are outside of the scope of the Code, and intended to be addressed separately by the appropriate departments within a Naval Administration.

3 Notation

As a recognized Class Society, ABS acts on behalf of the Naval Administration to verify compliance and issue the Naval Ship Safety Certificate (NSSC). This is discussed further in 6-4-1/5.7.

NavalSafe(x) is an optional notation assigned to the ship once the performance requirements of the defined chapter(s) of NSC are met and the Naval Ship Safety Certificate is issued. The index **x** in **NavalSafe(x)** notation represents: **S** (Structure), **BSC** (Buoyancy, Stability and Controllability, **ES** (Engineering Systems), **SS** (Seamanship Systems), **FS** (Fire Safety), **EER** (Escape, Evacuation and Rescue, **C** (Communication), **N** (Navigation), **DG** (Dangerous Goods), **All** (if all entries are applicable).

5 The Process for NSC Certification

The main regulatory elements in the certification process are shown in 6-4-1/Figure 1. The certification of the ship is to be based on a Concept of Operations Statement (ConOpS) defining the ship's function, operational areas and characteristics. The Standards Plan is a list of the technical standards used as based on the goals, functional objectives, and performance requirements for the ship. The Technical File is a compiled list of all the ship specific information. A Naval Ship Safety Certificate and the **NavalSafe(x)** notation is to be issued upon a ship's confirmed compliance with the overall requirements.

FIGURE 1
Process for NSC Certification Simplified *(1 March 2018)*

5.1 Concept of Operations (ConOps) Statement

As seen in 6-4-1/Figure 1 above, the process for certification of a government ship begins with the concept of operations statement, or ConOpS. The ConOpS defines the ship's function, operational areas and characteristics, and serves as the basis for certification. The ConOpS is a list of the ship particulars. Examples are:

i) Mission or roles of the ship

ii) Ship attributes

iii) Displacement measurements

iv) Speed and endurance

v) Post damage capability (non-combat or threat related)

vi) Operational area

vii) Operational Philosophy

viii) Crew description

ix) Environmental operational limits:

  a) Including navigation in ice

x) NSC related engineering equipment:

  a) Propulsion machinery/equipment

  b) Fire safety related systems and gear

  c) Communications and navigation equipment

xi) Maintenance and survey schemes/periodicities

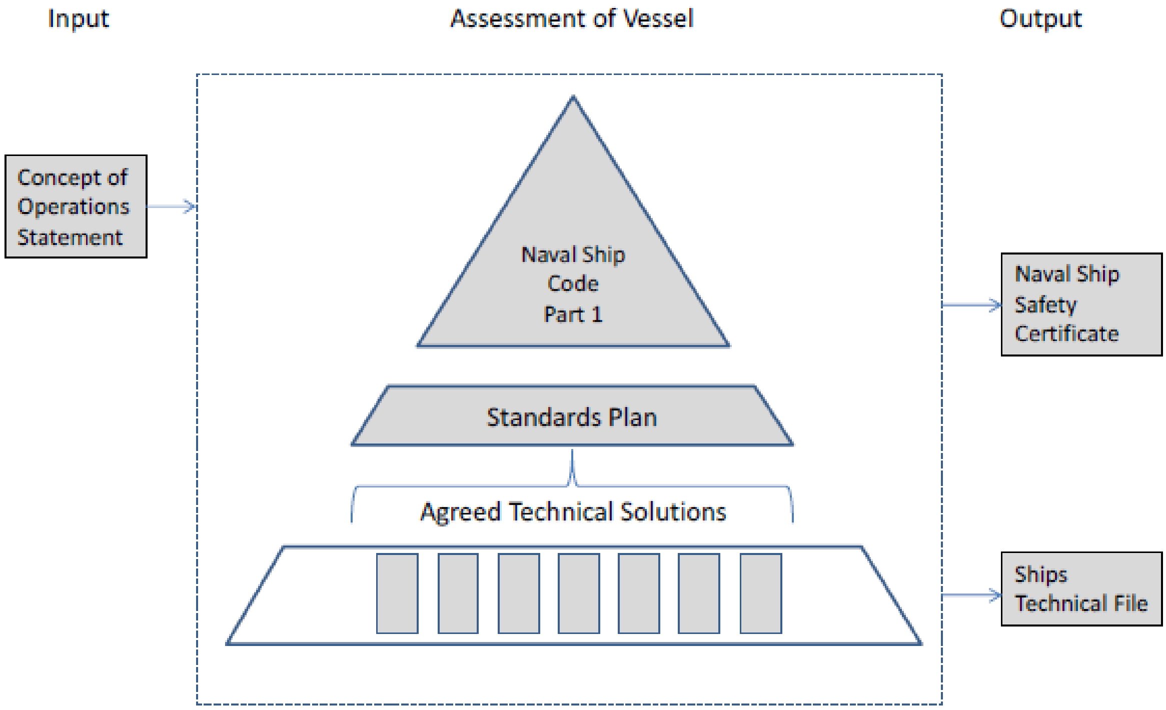
The above is the primary input for the assessment of the ship (see 6-4-1/Figure 2). Once established, the ConOpS is used to begin assessing the ship to Part 1 of the NSC (from Goals to Performance Requirements). Part 2 may be applied to determine agreed upon Solutions to satisfy Tier 1. NSC tier level expansion can be found below, see 6-4-1/7.

An example of a ConOpS form is presented in Part 3, Chapter I, Annex A of the NSC.

5.3 Standards Plan

The Standards Plan is comprised of a listing of technical standards. These are used to verify that the ship meets the Goals, Functional Objectives, and Performance Requirements as verified by the Naval Administration or its recognized organization(s), within the defining parameters of the ConOpS. For example, these may include industry or government design standards for safety equipment, IMO conventions either applied in part or in whole, the applicable rules of a classification society, or other options for solutions deemed appropriate for use as determined by the Naval Administration. This plan is essentially a list or spreadsheet and forms the basis for the Tier 4 Solutions. An example of a Standards Plan form is presented in Part 3, Chapter I, Annex B of the NSC.

FIGURE 2
Main Regulatory Elements in the Certification Process of Ships *(1 March 2018)*



(Source: Naval Ship Code, ANEP 77, Figure P1-I-1)

As the NSC certification process is in progress, documentation is to be created to maintain configuration control of the overall process. These documents will eventually be collected to create the Technical File.

5.5 Technical File

The ship technical file contains information showing how the requirements of the Code have been applied to the ship design and construction. The file is to be complete at delivery of a new ship, provided all aspects of the Code being invoked for this design have been addressed. A typical Technical File may include, but is not limited to, the following:

i) A copy of ConOpS

ii) Applicable NSC Parts/Chapters being invoked

iii) Applicable NSC Tier level being invoked

iv) The complete Standards Plan

v) Interpretations/Justifications made during the NSC certification process

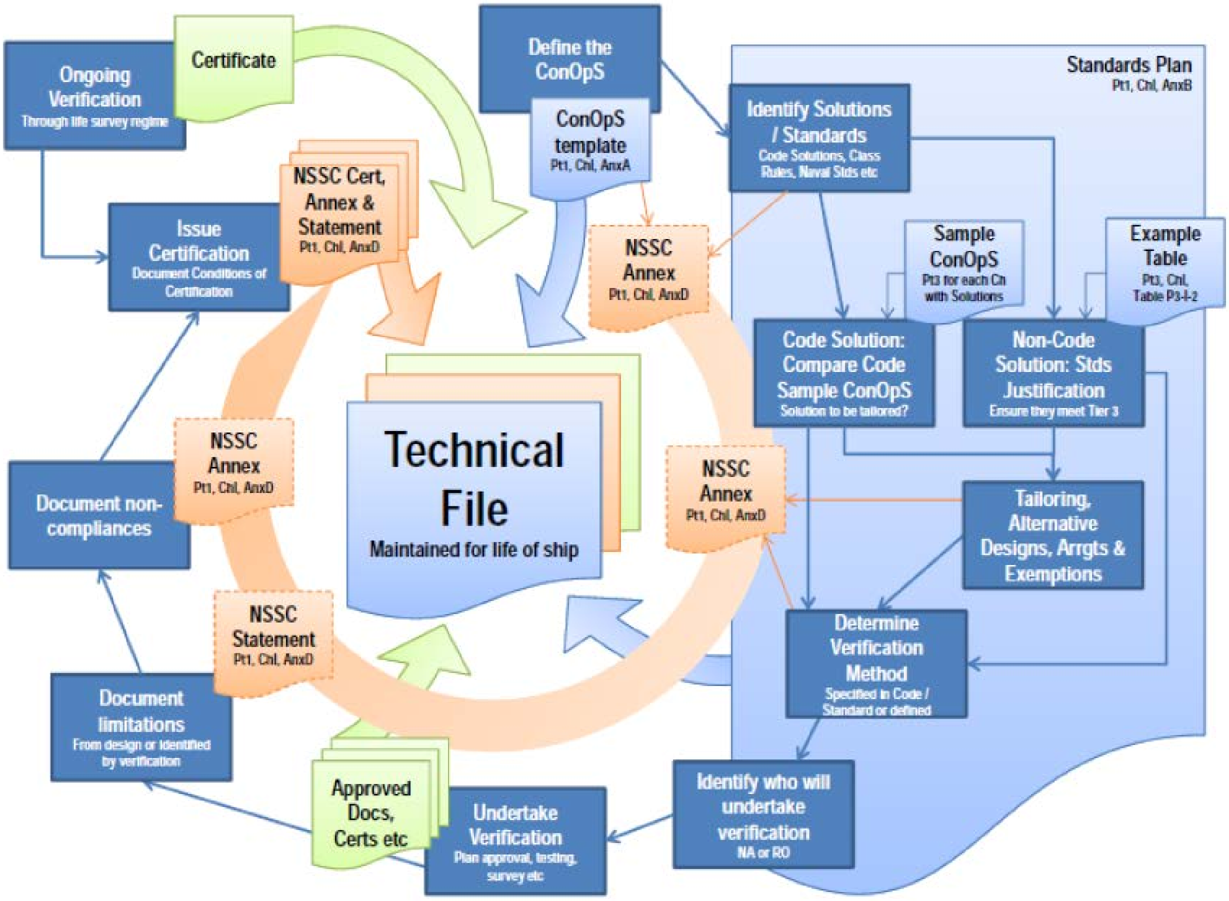
vi) Classification Society information (Rule sets, notations, etc.)

vii) Statutory certificates

viii) Other information as needed

The Technical File is a living document and must be updated to address events such as modifications and modernization initiatives throughout the ship's operational life. The process for technical file compilation is shown in 6-4-1/Figure 3 below.

FIGURE 3
Process for Compilation of a Technical File *(1 March 2018)*



(Source: Naval Ship Code, ANEP 77, Figure P3-I-2)

5.7 Naval Ship Safety Certification (NSSC)

Upon completion of the verification process, the ship may be issued a Naval Ship Safety Certificate (NSSC). This may be issued by the Naval Administration, or jointly with ABS as the recognized organization. The NSSC is to refer to information found in the ConOpS, Standards Plan, and ship construction files maintained by the classification society or Naval Administration. The NSSC contains the certificate itself, an Annex containing key design and verification information, and supporting data related to design information. Once completed, the NSSC then becomes part of the Technical File.

Much like a class certificate issued by a classification society, the NSSC is to be endorsed and renewed at regular intervals as determined by the Naval Administration.

The NSSC should be as clear as practicable in describing the technical standards used, and any determinations or major assumptions made during the NSC process. An example of a NSSC form is provided in Part 3, Chapter I, Annex C of the NSC.

7 Framework of the NSC

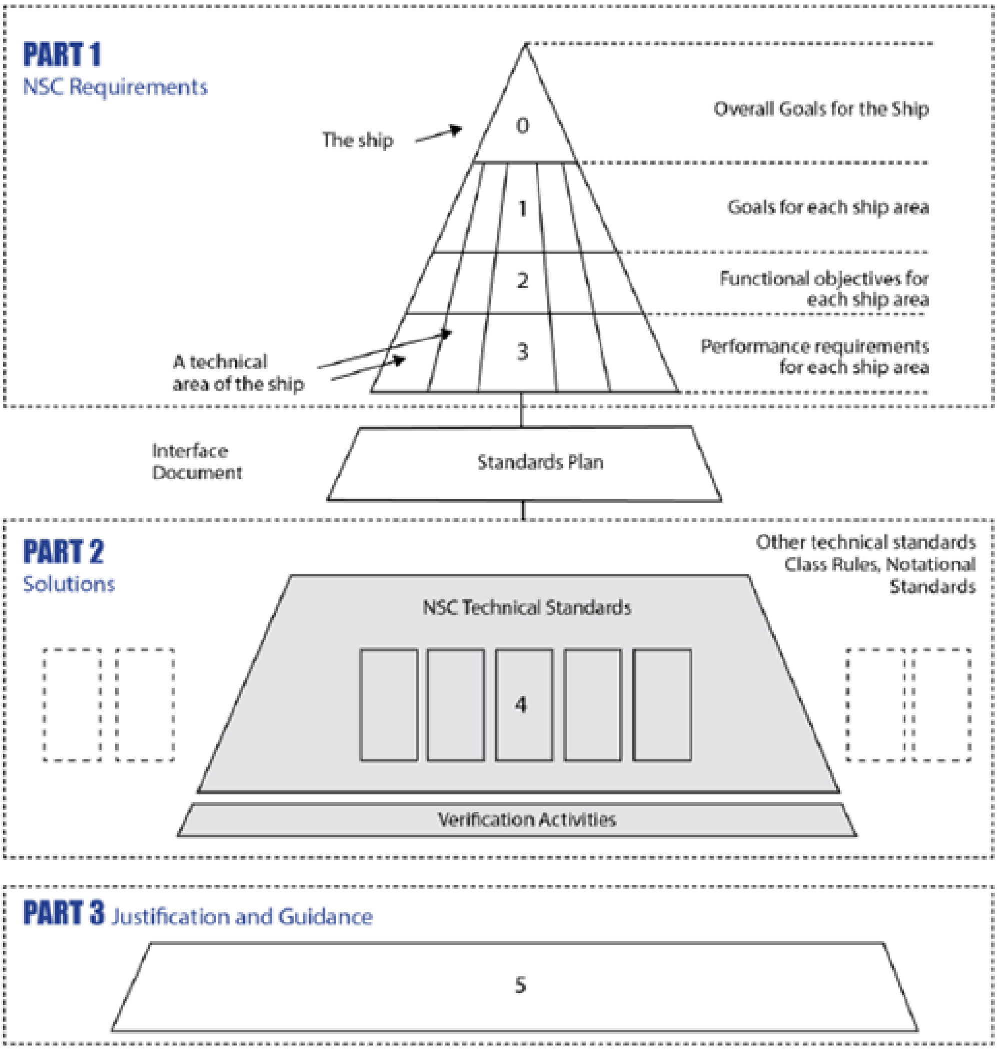
The Naval Ship Code includes three distinct Parts:

- Part 1: NSC Requirements
- Part 2: Solutions
- Part 3: Justification and Guidance

See 6-1-4/Figure 4 below. The increasing width of the triangle as the Naval Ship Code descends through the tiers implies an increasing level of detail. In addition, the vertical diagonals within the triangle refer to different technical areas within the ship, as addressed within the chapters. Each Part of the NSC contains essentially the same Chapters:

- Chapter 0 – Using the Naval Ship Code
- Chapter I – Naval Ship Safety Certification
- Chapter II – Structure
- Chapter III - Buoyancy, Stability and Controllability
- Chapter IV - Engineering Systems
- Chapter V - Seamanship Systems
- Chapter VI - Fire Safety
- Chapter VII - Escape, Evacuation and Rescue
- Chapter VIII - Communications
- Chapter IX - Navigation
- Chapter X - Dangerous Goods

FIGURE 4
Arrangement of the Naval Ship Code *(1 March 2018)*



(Source: Naval Ship Code, ANEP 77, Figure P1-0-3)

7.1 Part 1

Part 1 contains the overall goals for the ship, and is found in Regulation 1 of Part 1, Chapter 1 ("Naval Ship Safety Certification"). The ship is to be designed, built and maintained so that when operated within the determined ConOpS, the ship:

i) Is safe to operate and prevents injury of crew onboard and

ii) Possesses essential safety functions for crew in foreseeable damage circumstances.

It is important to note that, for "special ship concepts", these goals may be modified if agreed to by the Naval Administration; but risks are to be kept as low as practicable. However, in addition to these stated goals, the Naval Administration may add additional goals. As visually demonstrated by the pyramid in 6-4-1/Figure 4, the top goal is achieved through the achievement of the goals found in each chapter; these in turn are met through the successful completion of the Functional Objectives and Performance Requirements for each ship technical area. This plan provides flexibility as to the manner in which certification may be achieved. And, while it is emphasized that the Code is not mandatory, and it is not required to be invoked in its entirety, use of only parts of the Code are not recommended as hazards can be interdependent on one another.

It is noted that between Part 1 and Part 2, 6-4-1/Figure 4 refers to an "interface document" described as the "Standards Plan"; this item is discussed in 6-4-1/5, "The Process for NSC Certification".

- *Tier 0 and 1 – Aim Goals:* High-level objectives to be met.
- *Tier 2 – Functional Objectives:* Criteria to be satisfied in order to conform to the goals.
- *Tier 3 – Performance Requirements:* Detailed requirements for meeting Tiers 1 and 2 for each technical area of the ship.

7.3 Part 2

Part 2 contains suggested solutions for the functional objectives and performance requirements found in Part 1.

Options are also provided for verification. The solutions provided may be followed; or as an alternative the rules of a classification society, international convention (such as IMO SOLAS), or a suitable additional standard may be used to facilitate verification of the performance requirements. The Code allows the Naval Administration to continue to use the existing standards, systems and equipment used previously, should these items meet the requirements. In most cases in Part 2, these solutions may either be verified by the Naval Administration, or by an RO (such as a classification society).

- *Tier 4 – Solutions:* Detailed requirements (such as standards and class rules) applied by national Administrations and/or recognized organizations acting on their behalf, in order to verify compliance with the above Tiers. These solutions are not mandatory and can be substituted with other solutions by the Naval Administration, that are agreed as appropriate for the ship and Justified as meeting the Functional Objectives and Performance Requirements set out in Part 1.

7.5 Part 3

Part 3 contains the final tier of the pyramid, and provides justification and guidance to support the Naval Ship Code Performance Requirements and Solutions to adequately satisfy the Goals. In addition, and perhaps even more critical, it provides the history and reference data provided by all applicable parties who contributed to each part and chapter. It discusses the origin of many of the sections and is presented in a tabular format. In this way, the guidance provides the foundation for future development for the NSC.

- *Tier 5 – Justification and Guidance:* This section is principally composed of the historical background for each corresponding section in Naval Ship Code Parts 1 and 2, including standards referenced and codes of practice, as well as safety and quality systems for shipbuilding, ship operation, maintenance, training, and manning, which may be incorporated into or referenced in Tier 4.

9 Survey

The surveys after construction for Naval Ship Safety are to be in accordance with the applicable requirements in the NSC.

The vessel and applicable systems are to be generally examined based on the submitted and reviewed survey plan, which is required to achieve the optional class notation **NavalSafe(x)** and the Naval Ship Safety Certification as prescribed by Naval Ship Code.

No alterations that affect or may affect the awarded **NavalSafe(x)** notation are to be made to the ship unless plans of the proposed alterations are submitted to and approved by ABS before the work is commenced. If ABS determines that the alteration will affect the **NavalSafe(x)** notation, the altered ship may be subject to the review and verification requirements of this Guide.