Guide for

Special Loading of Ore and Ore/Oil Carriers

February 2023

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SPECIAL LOADING OF ORE AND ORE/OIL CARRIERS
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American Bureau of Shipping
Incorporated by Act of Legislature of
the State of New York 1862

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Foreword

With the drive for increasing loading and unloading efficiency at many ore cargo terminals, there is a strong desire in the shipping industry for optional classification notations for vessels carrying ore cargoes that are compatible with the high loading rates at these terminals. This Guide is developed and issued to address this demand with design and loading guidance. The evaluation procedure and technical requirements are to be used for verifying the eligibility of a vessel for the optional notations **LDCARE1** (Loading Care 1) and **LDCARE2** (Loading Care 2).

In addition, iron ore fines having a moisture content in excess of the Transportable Moisture Limit (TML) are only to be carried in specially constructed, or in specially fitted, cargo ships according to Paragraph 7.3.1.1 of the IMSBC Code. Due to the lack of specific requirements in IMO regulations and ABS Rules for vessels capable of carrying iron ore fines with moisture content in excess of the TML, this Guide provides both stability and hull strength requirements for this purpose with the optional notation **TML**.

This Guide becomes effective on the first day of the month of publication.

Users are advised to check periodically on the ABS website www.eagle.org to verify that this version of this Guide is the most current.

We welcome your feedback. Comments or suggestions can be sent electronically by email to rsd@eagle.org.

GUIDE FOR

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SECTION 1
Introduction

1 General

The structural strength criteria in the ABS *Rules for Building and Classing Marine Vessels (Marine Vessel Rules)* are the basis to establish the required scantlings for vessels classed by ABS. For vessels carrying ore cargoes, Part 5C, Chapter 3 of the *Marine Vessel Rules* is applicable to the vessel configurations for ore carriers and ore/oil carriers. The hull structure is required to be evaluated against the failure modes of yielding, buckling, and fatigue under the design loads in the *Marine Vessel Rules*.

The hull structure constructed to the *Marine Vessel Rules* is to be properly maintained throughout the vessel's service life and the vessel is to be operated within the loading envelope curves in the approved Loading Manual and Loading Program.

The high loading rates at many ore cargo terminals may lead to the exceedance of a vessel's loading envelopes, wherein the hull-structure is stressed close to or beyond its strength limits. Vessels carrying ore cargoes can be more explicitly designed to tolerate onerous loading processes. This Guide defines the design parameters for such loading tolerance and provides the evaluation procedure and technical requirements for the optional notations **LDCARE1** (Loading Care 1) and **LDCARE2** (Loading Care 2).

In addition, iron ore fines having a moisture content in excess of the Transportable Moisture Limit (TML) are only to be carried in specially constructed, or in specially fitted, cargo ships according to Paragraph 7.3.1.1 of IMSBC Code. Due to the lack of specific requirements in IMO regulations and ABS Rules for vessels capable of carrying iron ore fines with moisture content in excess of the TML, this Guide provides both stability and hull strength requirements for this purpose with the optional notation **TML**.

3 Application

To be eligible for the optional notations **LDCARE1** (Loading Care 1) and **LDCARE2** (Loading Care 2) and/or **TML**, vessels for carrying ore cargoes are to comply with Part 5C, Chapter 3 and Part 5C, Appendix 1 of the *Marine Vessel Rules* and recognized with the notations **SH, SHCM**.

5 Notations

Vessels carrying ore cargoes that comply with the requirements in Subsection 2/1 of this Guide may be distinguished in the ABS Record with the optional notation:

LDCARE1 (ore loading/unloading rate xx MT/hour, yy minutes overshooting)

Vessels carrying ore cargoes that comply with the requirements in Subsection 2/3 of this Guide which are fitted with automatic draft reading sensors, as well as an automatic level-gauging system for all ballast tanks linked to the onboard loading program, may be distinguished in the ABS Record with the optional notation:

LDCARE2 (ore loading/unloading rate xx MT/hour, yy minutes overshooting)

Vessels carrying iron ore fines that comply with the requirements in Section 3 of this Guide and Section 5C-3-A3 of the *Marine Vessel Rules*, may be distinguished in the ABS Record with the optional notation:

TML

SECTION 2

Requirements for LDCARE1 and LDCARE2

1 Evaluation Requirement for LDCARE1

Compliance with the requirements for the optional notation **LDCARE1** is to be documented and demonstrated in accordance with the sections listed below in the *Marine Vessel Rules* and the requirements as follows.

- Documentation in 5C-3-A3/9.1.1
- Evaluation Procedure in 5C-3-A3/9.3
- Target loading processes in 5C-3-A3/9.5
- Compliance with the allowable still-water loading limits in 5C-3-A3/9.7
- Compliance with the allowable mass curves in 5C-3-A3/9.9
- Intermediate calculations in 5C-3-A3/9.11
- Total strength assessment against cargo overshooting in 5C-3-A3/9.13
- Vessels carrying ore cargoes with **SH** notation in 5C-3-A3/9.15
- Ballast system in 5C-3-A3/9.17

If two or more pieces of loading/unloading equipment are used for simultaneous loading/unloading, the intermediate strength checks are to be carried out based on the same principle in 5C-3-A3/9.11 of the *Marine Vessel Rules* considering the total loading rate of all loading/unloading equipment.

The ballasting/de-ballasting pump capacity of the vessel is to be at least 75% of the average unloading/loading rate of the equipment.

3 Evaluation Requirement for LDCARE2

Compliance with the requirements for the optional notation **LDCARE2** is to be documented and demonstrated in accordance with Subsection 2/1 above, and the requirements for automatic draft reading sensors and automatic level-gauging systems in 5C-3-A3/9.19 of the *Marine Vessel Rules*.

SECTION 3
Requirements for TML

1 Iron Ore Fines That May Liquefy

Cargoes having a moisture content in excess of the transportable moisture limit are only to be carried in specially constructed, or in specially fitted, cargo ships as indicated in IMSBC Code 7.3.2. Specially constructed ore carriers and ore/oil carriers capable of carrying iron ore fines having a moisture content in excess of the Transportable Moisture Limit (TML) and which comply with the requirements in this Section may be assigned the optional notation **TML**. The optional class notation **TML** provides both hull strength and stability requirements for the application.

The flag Administration is to be approached for concurrence for compliance with the requirements to specially constructed cargo ships capable of carrying iron ore fines having moisture content in excess of the TML according to the IMSBC Code.

Commentary:

The representative properties of iron ore fines and iron ore concentrates from Brazil are as follows for reference:

a) Stowage factor (m^3/t)		0.28 ~ 0.53 (both cargoes with moisture content below and above TML)
b) Density range (t/m^3)		1.89 ~ 3.57
c) TML range		7.6% ~14.2%
d) Angle of repose	Dry:	33 to 40 degrees
	Liquefied:	0 degree
e) Permeability		0.30 – 0.35

End of Commentary

3 Cargo Hold Structure

The strength criteria provided below are based on net scantlings, where the nominal design corrosion values for plating and structural members are given in 5C-3-A3/3 of the *Marine Vessel Rules*.

The design conditions are to consider the most severe operational cargo conditions listed below from the loading manual:

- *Homogeneous Loading Condition.* Liquefaction in one hold and no liquefaction in adjacent hold
- *Alternative Loading Condition.* Liquefaction in loaded cargo hold

3.1 Initial Scantling Criteria

In addition to the initial scantling criteria indicated in Appendix 5C-3-A3 of the *Marine Vessel Rules* for ore and ore/oil carriers, the structural scantlings of cargo hold boundaries are to comply with the requirements in the *Marine Vessel Rules* listed below with nominal pressure p, p_ℓ and p_u:

- Inner bottom plating: 5C-3-4/7.3.2 (except thickness requirement t_5 and t_6)
- Inner bottom longitudinals: 5C-3-4/7.5
- Sloping bulkhead plating: 5C-3-4/21.1
- Sloping bulkhead longitudinals: 5C-3-4/21.11
- Vertically corrugated transverse bulkhead plating: 5C-3-4/25.3
- Vertically corrugated transverse bulkhead unit corrugation: 5C-3-4/25.5
- Cross ties in ballast tanks adjacent to cargo holds: 5C-1-4/15.11

The liquefied iron ore fines are to be treated as homogeneous liquid when calculating the pressure and assessing the structural strength. The nominal pressure is to be determined based on the equation given in 5C-1-3/5.7.2 of the *Marine Vessel Rules* considering the actual filling height of the cargo hold from loading manual and the specified density of liquefied iron ore fines.

3.3 Total Strength Assessment

In addition to the total strength assessment indicated in Appendix 5C-3-A3 of the *Marine Vessel Rules* for ore and ore/oil carriers, the strength of the cargo hold boundary and main supporting members are to be evaluated as indicated below for compliance with the yielding and buckling strength criteria specified in Appendix 5C-3-A3 of the *Marine Vessel Rules*. The structural strength of the foremost and aftmost cargo holds is to be verified by finite element analysis.

Load Cases 5 and 6 in 5C-3-A3/Figure 1 of the *Marine Vessel Rules* modified with the specified density of liquefied iron ore fines are to be investigated. External pressure and internal pressure due to liquefied iron ore fines and ballast, as applicable, are to be calculated in accordance with Section 5C-3-3 and Appendix 5C-3-A3 of the *Marine Vessel Rules*, respectively.

The liquefied iron ore fines are to be treated as liquid cargo and the cargo pressure is to be determined based on the equations given in 5C-3-3/5.7.2 of the *Marine Vessel Rules*, where the angle of repose α_0 is taken as 0° considering the actual filling height of the cargo hold from loading manual and the specified density of liquefied iron ore fines.

5 Stability

5.1 Intact Stability

The vessel is to comply with the intact stability criteria in the IMO Code on Intact Stability 2008, Part A, Chapter 2, taking into consideration the free surface effect (FSM) caused by liquefied cargo. The cargo is to be assumed as liquid in the FSM calculation.

If it is not practicable for the maximum righting lever to occur at an angle of heel not less than 25°, the following alternative criteria may be applied as an equivalent level of safety, subject to approval by the flag Administration.

i) The maximum righting lever should occur at an angle of heel not less than 15°; and

ii) The area under the curve of righting lever is not to be less than the value obtained by the formula below:

$$0.055 + 0.001(30° - \theta_{max}) \quad \text{meter-radians}$$

where, θ_{max} is the angle of heel in degrees at which the righting lever curve reaches its maximum.

In addition, the following intact stability criteria are to be complied with after considering the transverse heeling moments assuming the cargo shift of 25° (see Section 3, Figure 1 and Figure 2):

i) The angle of heel θ_1 is not to be greater than 12° or the angle at which the deck edge is immersed, whichever is less,

ii) The residual area A_R between the heeling arm curve and the righting arm curve up to the angle of heel of maximum difference between the ordinates of the two curves, or 40° or the angle of flooding (θ_d), whichever is the least, is to be not less than 0.075 meter-radians, and

iii) The initial metacentric height GM_o, after correction for free surface effects of liquids in tanks and liquefied cargoes in cargo holds, is to be not less than 0.30 m.

FIGURE 1

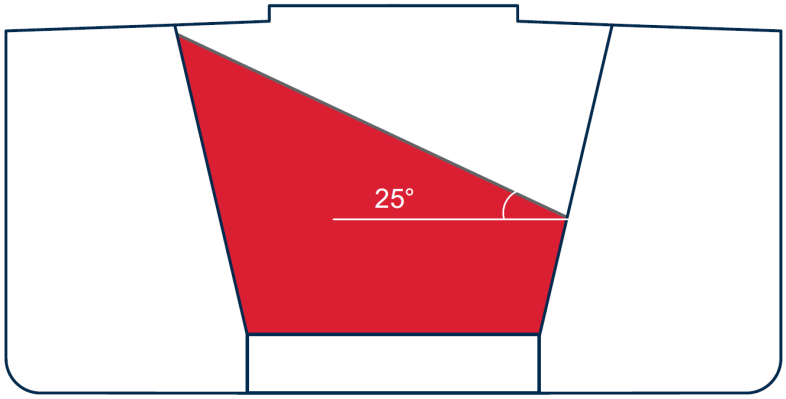
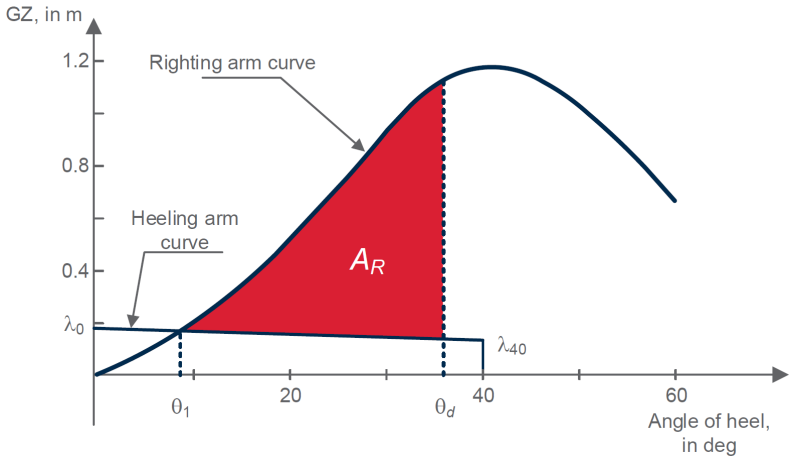


FIGURE 2



where

θ_1 = angle of heel due to shift of cargo with moisture content not less than the transportable moisture limit, in degrees

θ_d = angle of heel, in degrees, of the maximum difference between the ordinates of the two curves, or 40° or the angle of flooding (θ_d), whichever is the least

λ_0 = sum of volumetric transverse heeling moments due to cargo shift × density of cargo × 1.12 / displacement

λ_{40} = $0.8 \times \lambda_0$

5.3 Damage Stability

The damage stability requirements in Regulation 9 and Regulation 12.2, Chapter II-1, Part B-2 of SOLAS and/or Regulation 27 of ICLL 1966 and Protocol of 1988, as amended, are to be assessed without considering liquefied iron ore fines.

SECTION 4
Surveys

1 Surveys During Construction/Initial Survey

Prior to assigning the optional notations **LDCARE1**, **LDCARE2**, and **TML**, the following are to be carried out:

i) Loading computer is to be functionally tested and verified in compliance with the approved Load cases for the specific notations (**LDCARE1**, **LDCARE2**, and **TML**).

ii) Ballasting system is to be tested for proper operation.

iii) For the optional notation **LDCARE2,** the interface of the draft reading sensors and level-gauging system with the loading computer is to be demonstrated to the attending Surveyor's satisfaction.

3 Surveys After Construction

3.1 Annual Surveys

At each Annual Survey, functional and operational testing is to be carried out as specified in Subsection 4/1 to the Surveyor's satisfaction.

i) Loading computer is to be functionally tested and verified in compliance with the approved Load cases for the specific notations (**LDCARE1**, **LDCARE2**, and **TML**).

ii) Ballasting system is to be examined to confirm no unauthorized modifications.

iii) For the optional notation **LDCARE2,** the interface of the draft reading sensors and level-gauging system with the loading computer is to be demonstrated to the attending Surveyor's satisfaction.

3.3 Special Periodical Surveys

At each Special Periodical Survey, the following are to be carried out to the Surveyor's satisfaction.

i) The Annual Survey requirements as specified in 4/3.1 are to be carried out to the Surveyor's satisfaction.

ii) Verification that no unauthorized modifications to the structure have been carried out.

iii) In addition, for vessels with **TML** notation, at Special Periodical Survey No. 2 and subsequent, the thickness measurements of Cargo Hold bulkheads are to be submitted to Engineering for their evaluation and confirmation that the vessel meets the Total Strength requirements referenced in 3/3.3.