



**GUIDE FOR**

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**LNG FUEL READY VESSELS**

**DECEMBER 2014**

**American Bureau of Shipping  
Incorporated by Act of Legislature of  
the State of New York 1862**

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## Foreword

Due to increasingly stricter environmental regulations controlling air pollution from ships, together with the potential for favorable price conditions, the use of LNG as a fuel, instead of conventional residual or distillate marine fuels, is expected to become more widely adopted in the future. In anticipation of this trend, the marine industry is looking for ways to provide flexibility and capability in vessel designs to enable a future conversion to an alternative fuel, such as LNG.

This will provide the flexibility to limit the initial investment while maintaining the option to select LNG, or another low flashpoint fuel, as a fuel in the future. This arrangement may be called “LNG Fuel Ready”. The scope of such modifications can significantly differ from ship to ship and needs to be agreed between the shipowner and the shipbuilder.

It is important to note that the only international regulations currently in place for gas fueled ships, other than those covered by the IGC Code, are those included in the IMO Resolution MSC.285(86) *Interim Guidelines on Safety for Natural Gas-Fuelled Engine Installations in Ships*, which was adopted 1 June 2009. These guidelines will be replaced by the IMO *International Code of Safety for Ships Using Gases or Other Low Flashpoint Fuels* (IGF Code), which at the time of issuance of this Guide is expected to be in early 2017.

Users of this Guide should be aware that due to changing regulations, and depending on specific geographical uses, compliance with this Guide may not necessarily reflect all requirements in all regions at the time of construction or future conversion.

The intent of this Guide is to provide guidance to shipowners and shipbuilders indicating the extent to which a ship design has been prepared or “ready” for using LNG as a fuel. The actual ABS requirements to be applied to gas fueled ships are detailed in the *ABS Guide for Propulsion and Auxiliary Systems for Gas Fueled Ships* (herein after referred to as the *Gas Fueled Ships Guide*). The purpose of this Guide is to indicate the extent to which a vessel has been prepared or “ready” for compliance with the *Gas Fueled Ships Guide*. It is to be noted that compliance with the applicable edition of the *Gas Fueled Ships Guide* in force at the time the “LNG fuel ready” service is provided does not guarantee compliance with the edition of the *Gas Fueled Ships Guide* as may be applicable at the time the future conversion to a gas fueled ship is actually undertaken.

Furthermore, compliance with the *Gas Fueled Ships Guide* requirements does not necessarily indicate compliance with the statutory requirements that may be in place at the time of vessel conversion. Where the requirements of the *Gas Fueled Ships Guide* are proposed to be used to comply with IMO Resolution MSC.285(86), or the IMO IGF Code, such application is subject to approval by the flag Administration prior to issuance of the Safety Certificates on behalf of the flag Administration by ABS.

The applicable edition of the *ABS Rules for Building and Classing Steel Vessels* is to be used in association with this Guide.

Despite the foreseen trend of using LNG as a fuel, the decision of building a new ship or converting an existing one to LNG fueled is not simple, due to the current limited bunkering infrastructure, the uncertainty of LNG price advantage worldwide, and the many technical challenges that need to be faced during the design of all the associated systems, especially in the absence of finalized International Codes and Standards. However, considering the promise of the advantages that may be gained from use of LNG as marine fuel at the time of the issuance of this Guide, the shipbuyers concerned with such difficulties may decide to place ship orders with conventional oil fuel burning arrangement with additional provision for using LNG as a fuel with the intention to complete installation in the future. This arrangement may be called “LNG Fuel Ready”. In order to facilitate future modifications, the shipbuyers and shipbuilders must make a significant effort to figure out what features should be incorporated on a vessel and incorporate these in the shipbuilding contract.

ABS recognizes the need for defining the “LNG Fuel Ready” scheme in the marine industry, which identifies all technical issues that must be considered and thereby assist owners, designers, and builders in taking this route.

This Guide has been developed considering that the following elements may be desired by owners opting for features of LNG readiness in the Classification of their vessels.

- i)* The first is an independent and public recognition that a vessel has been designed intentionally with feasible LNG fuel conversion in mind and that it has physical features that make it suitable for such conversion.
- ii)* The second addresses the need for owners to specify instructions to the builder in terms of Class guidance and requirements.
- iii)* The third provides confirmation to the owner and the shipbuilder that any vessel features agreed between the two parties have been approved by the Classification society based on their Rules that would be applied if the vessel had been built as a gas fueled ship to the concept proposed.

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](http://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](mailto:rsd@eagle.org).*



# GUIDE FOR LNG FUEL READY VESSELS

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## SECTION 1 General

### 1 Scope and Application

This Guide is for optional application to ship types other than those falling under the scope of the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (IGC Code) and the ABS requirements under Part 5C, Chapter 8 of the *ABS Rules for Building and Classing Steel Vessels (Steel Vessel Rules)* and burning their cargo. It is applied to vessels burning conventional fuels but having design features suitable to permit conversion at a future date to a particular gas burning concept based on existing Class requirements for gas fueled ships.

The requirements for the design and construction of all features of systems proposed are established in the *ABS Guide for Propulsion and Auxiliary Systems for Gas Fueled Ships (Gas Fueled Ships Guide)*.

It is of course recognized that after the conversion of a vessel to LNG fueled, the arrangements and installations will still be subject to approval by the flag Administrations and the flag Administration will implement the IMO requirements in effect at the time of conversion. The Interim Guidelines on Safety for Natural Gas-Fuelled Engine Installations in Ships were adopted by International Maritime Organization (IMO) Resolution MSC.285(86) on 1 June 2009, which invites governments to apply the Interim Guidelines to gas fueled ships other than those covered by the IGC Code. However, they will be replaced once The International Code for Safety for Ships Using Gases or Other Low Flashpoint Fuels (IGF Code) becomes effective. The IGF Code is scheduled to become effective in 2017, and while it is still not finalized at IMO, it will contain a number of changes to the present requirements specified in the Interim Guidelines.

This Guide is to be applied to both new construction and existing vessel conversions, regardless of size, utilizing natural gas as fuel.

### 3 Objectives

The objective of this Guide is to define a three (3) leveled “LNG Fuel Ready” scheme, to provide the details and preparations needed for each Level, and to describe the type of recognition that ABS will offer subject to compliance of the requirements at each Level.

There are three Levels considered as fundamental for defining the readiness of a vessel that is requested to be listed under the “LNG Fuel Ready” scheme. A *Level 1 – Concept Design Review* is conducted prior to subsequent application of *Level 2* or *Level 3*. These are briefly described below:

- *Level 1 – Concept Design Review* – This is a high level evaluation of the basic suitability of a particular vessel design to be able to fit a particular LNG fueled ship concept.
- *Level 2 – General Design Review* – This Level is additional to Level 1, and it is categorized in separate groups identifying the different parts of the complete design.
- *Level 3 – Detail Design Approval and Installation* – This is the final Level of the “LNG Fuel Ready” scheme and incorporates both the Class Approval of the detailed drawings and the installation of parts of the system and specified equipment onboard the vessel including Survey in accordance with the related requirements of the *Gas Fueled Ships Guide*.

## 5 Recognition

Upon satisfactory completion of each review level, ABS shall provide the following recognition of the extent to which compliance with the *Gas Fueled Ships Guide* has been established:

- *Level 1* – An Approval in Principle (AIP) for the concept design and a Record Statement will be created.
- *Level 2* – A suitably worded Statement of Compliance with the applicable Rules at the time of review with conditional information required for actual conversion. A Record Statement will be created.
- *Level 3* – A Class Notation **LNG Ready** with a description note introduced in the *Record* listing the parts of the system that have been installed in accordance with approved plans and to the satisfaction of the Surveyor prior to delivery of the vessel.

*Note:* In the future once the vessel has undergone a complete conversion to a gas fueled system that is shown to be in compliance with the *Gas Fueled Ships Guide*, in accordance with approved plans and to the satisfaction of the Surveyor, the above “LNG Fuel Ready” recognitions will be dropped and the appropriate Class Notations associated with a Gas Fueled Ship will be assigned.



## SECTION 2 LNG Fuel Ready Levels

### 1 Level 1 – Concept Design Review

#### 1.1 Description

This is a high level evaluation of the basic suitability of a particular vessel design to be able to fit a particular LNG fueled ship concept design. Basic suitability would mean that the geometry and structural arrangements of the vessel can physically encompass the necessary equipment and the safety elements associated with tank location and that the hazardous areas can be accommodated in compliance with the *Gas Fueled Ships Guide* at the time of the review. Upon satisfactory completion of this review level, ABS may provide an Approval in Principle (AIP) for this concept design and a Record Statement will be created.

#### 1.3 Plans and Data to be Submitted

The following plans and documentation shall be submitted for review:

- Concept Design Safety Assessment including propulsion and auxiliary arrangement requirements detailed under 2/5.1 of the *Gas Fueled Ships Guide*.
- Ship general arrangement
- LNG fuel storage tank type, capacity, location, and arrangement
- LNG fuel storage natural boil-off rate
- Fuel gas management plan
- LNG fuel bunkering station location and arrangement
- Fuel gas supply system arrangement
- Arrangement of machinery space including Gas Valve Unit
- Fuel Gas Handling equipment location and arrangement
- Preliminary hazardous areas classification plan
- Vent mast and venting location and arrangement
- Fuel gas piping arrangement
- Preliminary trim and stability, longitudinal strength, and visibility study in respect to the effect of the storage tank

### 3 Level 2 – General Design Review

#### 3.1 Description

This Level is additional to Level 1 and it is categorized in separate groups identifying the different parts of the complete design. The level of the design details to be reviewed for each system would be general. Detailed information such as particular equipment manufacturers and installations are not required except for the gas consumers. For new construction vessels, the drawings and supporting documentation shall be reviewed for compliance with the ABS Rules for gas fueled ships having the same applicability date as the Rules applied for Classification of the vessel. Upon satisfactory completion of this review, ABS may issue a suitably-worded Statement of compliance with the applicable Rules at the time of the review with conditional information required for actual conversion. A Record Statement will be created. The reviewed drawings could then be used as part of the future conversion project pending flag State approval.

The subgroups of Level 2 are:

- i) Hull structural reinforcement for LNG storage tank
- ii) LNG fuel storage tank arrangements
- iii) Fuel gas bunkering system and arrangement
- iv) Fuel gas supply system
- v) Gas vapor handling system
- vi) Gas consumers (engines, gas turbines and auxiliaries)

### **3.3 Plans and Data to be Submitted**

The plans and documents to be submitted for each group of Level 2 are listed below.

#### **3.3.1 Hull Structural Reinforcement for LNG Storage Tank**

- LNG storage tank type, dimensions, and volume
- Tank supports, collision chocks, and anti-floatation arrangements
- Material specifications for tank supports and steel grade selection for the hull in way of the tank
- Fuel gas storage tank thermal insulation with heat transfer calculation, as referenced by 2/2.2.2iv) of the *Gas Fueled Ships Guide*, for confirming the steel grade selection for the hull in way of the tank
- Specifications of design loads and structural analyses for the gas storage tank supports and hull reinforcement for accommodating the LNG storage tank together with complete stress analysis, as applicable

#### **3.3.3 LNG Fuel Storage Tank Arrangements**

- General arrangement of the gas storage tank(s), and as applicable, hold space/gas fuel storage room
- LNG storage tank supports, collision and anti-floatation arrangements
- Tank pressure accumulation calculation, as referenced by 2/6.1vii) of the *Gas Fueled Ships Guide*
- Tank relief valves capacity and discharge piping arrangements
- Ventilation and inert gas arrangement for tanks located inside the hull
- Gas fuel piping arrangement in way of the LNG fuel tank

#### **3.3.4 Fuel Gas Bunkering System and Arrangement**

- General arrangement of the gas fuel bunkering system
- Bunkering station, manifolds, and valves drawings
- Gas fuel piping systems including piping diagrams and associated components and design pressures and temperatures
- Bunkering station ventilation system capacity and arrangement
- Emergency shutdown (ESD) arrangements and ESD flow chart

#### **3.3.5 Fuel Gas Supply System**

- General arrangement of the fuel gas supply room
- Ventilation systems capacity and arrangement for the fuel gas supply room
- Gas fuel piping systems including piping diagrams and associated components and design pressures and temperatures

- Gas compressors and LNG pumps, with details such as type and size
- Vaporizers/heaters capacity, as applicable
- Pressure vessels specifications, as applicable
- Forced and natural boil-off gas supply system diagram from the tanks to the consumers

### 3.3.6 Gas Vapor Handling Systems

- Capacity and type of secondary means for handling excess natural boil-off gas
- General arrangement of the re-liquefaction unit compartment or the GCU compartment, as applicable
- Ventilation systems capacity and arrangement for the re-liquefaction unit compartment or the GCU compartment, as applicable
- Gas fuel piping systems including details of piping diagrams and associated components and design pressures and temperatures
- Gas compressors, specifications with type and size
- Gas heaters capacity
- Forced boil-off gas supply system from the tanks to the consumers piping diagrams and arrangements

### 3.3.7 Gas Consumers (Engines, Gas Turbines and Auxiliaries) Compartments

- General arrangements showing location of the power plant and individual items of machinery, such as the gas turbine units(s), exhaust gas boilers, turbo-generators(s), diesel generators, and other associated equipment (such as the gas combustion units(s), re-liquefaction plant and the gas supply line to the consumers)
- General arrangement of engine compartment(s) or the gas turbine engine enclosure, as applicable
- Ventilation system for engine compartment(s) capacity and arrangement, as applicable
- Gas fuel piping systems including details of piping and associated components and design pressures and temperatures

## 5 Level 3 – Detail Design Approval and Installation

### 5.1 Description

This is the final Level of the “LNG Fuel Ready” scheme and incorporates both the Class Approval of the detailed drawings and the installation of specified equipment onboard the ship. This Level is also categorized in separate groups, identifying the different parts of the complete design. Level 3 includes the complete list of drawings required for approval of each part before installation, and it can be performed straight after Level 1 or in combination with Level 2. Drawings are to be in compliance with the relevant sections of the *ABS Gas Fueled Ships Guide*. Upon completion of the installation to the Surveyor’s satisfaction, the vessel will be eligible for the class notation **LNG Ready**. A Record Statement will list each part of the system covered by the class notation. After delivery, the survey intervals and their requirements are covered in 2/5.5 below.

The subgroups of Level 3 are the same as Level 2, above:

- i) Hull structural reinforcement for LNG storage tank – Description S
- ii) LNG fuel storage tank structure – Description TS
- iii) LNG fuel storage tank arrangements – Description TA
- iv) Fuel gas bunkering system and arrangement – Description BK
- v) Fuel gas supply system – Description GS

- vi) Gas vapor handling system – Description VH
- vii) Gas consumers (engines, gas turbines and auxiliaries) – Description M
  - ME Main engines
  - AE Auxiliary engines
  - GT Gas turbines
  - B Main or Auxiliary boilers

The above descriptive letters will be included in the vessel record when the item of equipment or system indicated has been ABS approved/surveyed as per the applicable Rule/Guide requirements and installed on board to the attending Surveyor's satisfaction. For those instances when only part of a system or not all of the gas consumers are so installed, the applicable descriptive letter with appended brief description to indicate the installed equipment will be included. Some examples are indicated below:

- GS fuel gas piping
- BK manifold
- M-B DF boiler

### **5.3 Plans and Data to be Submitted**

The plans and documents to be submitted for each group of Level 3 are listed below.

#### **5.3.1 Hull Structural Reinforcement for LNG Storage Tank**

- Detailed drawings of the gas storage tank, supports, collision and anti-floatation arrangements
- Fuel gas storage tank thermal insulation and heat transfer calculation, as referenced by 2/2.2.2iv) of the *Gas Fueled Ships Guide*
- Material specifications for tank supports and steel grade selection for inner hull in way of the tank
- Specifications of design loads and structural analyses for the gas storage tank supports and hull reinforcement for accommodating the LNG storage tank together with complete stress analysis, as applicable
- Weld procedures, stress relieving, and nondestructive testing plans

#### **5.3.2 LNG Fuel Storage Tank Structure**

- General arrangement of the gas storage tank(s), and as applicable, hold space/gas fuel storage room, including location of the gas detectors, electrical equipment and lighting
- Detailed drawings of the gas storage tank supports and stays, secondary barrier, and insulation
- Material specifications for tanks, valves, and associated components
- Weld procedures, stress relieving, and nondestructive testing plans.
- Specifications of design loads and structural analyses for the gas storage tank(s) together with complete stress analysis as applicable
- Membrane tank sloshing analysis, where applicable, as referenced by 3/3i) of the *Gas Fueled Ships Guide*
- Filling limit curve, as referenced by 3/3vi) of the *Gas Fueled Ships Guide*
- Tank pressure accumulation calculation, where applicable, as referenced by 2/6.1vii) of the *Gas Fueled Ships Guide*

**5.3.3 LNG Fuel Storage Tank Arrangements**

- General arrangement of the gas storage tank(s), and as applicable, hold space/gas fuel storage room, including location of the gas detectors, electrical equipment, and lighting
- Detailed drawings of the gas storage tank supports and stays, secondary barrier, and insulation
- Calculation of gas storage tank relief valve capacity including back pressure and relevant supporting documents
- Ventilation or inert gas arrangements for the hold space/gas fuel storage room
- Fixed gas detection and alarm systems, and associated shutoff and shutdown systems
- Gas fuel piping systems including details of piping and associated components, design pressures and temperatures, and insulation, where applicable
- Descriptions and schematic diagrams for control and monitoring system including set points for abnormal conditions
- Details of all electrical equipment in the hold space/gas fuel storage room
- Electric bonding (earthing) arrangement
- Operating and maintenance instruction manuals (see 3/3vi), 3/3viii), and Subsection 3/2 of the *Gas Fueled Ships Guide*)
- Forced and natural boil-off gas supply system from the tanks to the consumers
- Testing procedures during sea/gas trials

**5.3.4 Fuel Gas Bunkering System and Arrangement**

The list of drawings to be submitted is to be in accordance with Subsection 4/2 of the *Gas Fueled Ships Guide*.

**5.3.5 Fuel Gas Supply System**

The list of drawings to be submitted is to be in accordance with 5/1.2 of the *Gas Fueled Ships Guide*.

**5.3.6 Gas Vapor Handling Systems**

The list of drawings to be submitted depends on the gas vapor handling system that will be selected, and it is to be in accordance with 6/1.3 and/or 7/1.2 of the *Gas Fueled Ships Guide*.

**5.3.7 Gas Consumers (Engines, Gas Turbines and Auxiliaries)**

The list of drawings to be submitted depends on the propulsion system that will be selected, and it is to be in accordance with 8/1.3 or Subsection 9/3 of the *Gas Fueled Ships Guide*.

**5.5 Survey**

**5.5.1 Survey at Vendor Shops and During Installation**

ABS attendance at the shops of equipment suppliers and on board the vessel during installation is to be carried out in accordance with the *Gas Fueled Ships Guide*.

**5.5.2 Survey after Construction**

ABS survey of the systems and equipment installed on the vessel will be included in the annual and special periodical surveys required in 7-6-2/3.7 of the *ABS Rules for Survey After Construction (Part 7)*.