



GUIDE FOR

**GAS AND OTHER LOW-FLASHPOINT FUEL READY
VESSELS
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American Bureau of Shipping
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Foreword

Due to increasingly stricter environmental regulations limiting air pollution from ships, together with the commitment and ambition from IMO to reduce GHG emissions from shipping, the use of LNG, methanol, ethane, LPG, hydrogen, ammonia and other gases or low-flashpoint fuels, in place 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 such alternative fuels.

The ability to convert to alternative fuels provides the flexibility to limit the initial investment while maintaining the option to select gases or other low flashpoint fuels in the future. This arrangement may be generically known as “Alternative Fuel Ready”. The scope of such preparation or modifications can significantly differ from ship to ship, and therefore, needs to be agreed upon between the shipowner and the shipbuilder on a case-by-case basis.

It is important to note that the international regulations pertaining to gas or other low flashpoint fueled ships, other than those covered by the IGC Code, are those included in the IMO *International Code of Safety for Ships Using Gases or Other Low Flashpoint Fuels* (IGF Code), which entered into force on January 2017.

This Guide has been developed for application to ships covered by the IGF Code, however ABS will consider application of the “Alternative Fuel Ready” program, recognition and notations of this Guide to ships falling under the scope of the IGC Code on a case-by-case basis, provided such proposals are arranged in accordance with the requirements of the IGC Code and with agreement of the flag Administration.

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 actual ABS requirements to be applied to gas or other low flashpoint fueled ships (other than those covered by the IGC Code) are detailed in Part 5C, Chapter 13 of the *ABS Rules for Building and Classing Marine Vessels (Marine Vessel Rules)*, which incorporates the aforementioned IGF Code. The purpose of this Guide is to indicate the extent to which a vessel has been prepared or “ready” for compliance with the *Marine Vessel Rules*. It is to be noted that compliance with the applicable edition of the *Marine Vessel Rules* in force at the time the “Alternative Fuel Ready” service is provided does not guarantee compliance with the later edition of the *Marine Vessel Rules* that may be applicable at the time the future conversion to a gas or other low flashpoint fueled ship is actually undertaken.

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

The decision to build a new ship or convert an existing one to be gas or other low flashpoint fueled is complex, due to the many technical and commercial challenges that need to be faced during the design of the vessel and all the associated systems. Ship owners/operators concerned with such difficulties may opt for ships with conventional oil fuel burning arrangements but with additional provisions and with the intention to complete modifications or additional installation in the future. This arrangement may be generically known as “Alternative Fuel Ready”. In order to facilitate future modifications, the ship owners and shipbuilders must make significant effort to determine which features should be incorporated on a vessel and include these in the shipbuilding contract.

ABS recognizes the need for defining an “Alternative Fuel Ready” program 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 “Alternative Fuel Ready” in the Classification of their vessels:

- i) An independent and public recognition that a vessel has been designed intentionally with feasible gas or other low flashpoint fuel conversion in mind and that it has physical features that make it suitable for such conversion.
- ii) Addressing the need for owners to specify instructions to the builder in terms of Class guidance and requirements.
- iii) 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 or other low flashpoint 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 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.



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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 Marine Vessels (Marine Vessel Rules)* and burning their cargo as fuel. It applies to vessels burning conventional fuels but having design features suitable to permit conversion at a future date to a particular gas or other low flashpoint fuel burning concept based on existing Class requirements.

Note:

ABS will consider application of the “Alternative Fuel Ready” program, recognition and notations of this Guide to ships falling under the scope of the IGC Code on a case-by-case basis, provided such proposals are arranged in accordance with the requirements of the IGC Code and 5C-8 of the *Marine Vessel Rules* and with agreement of the flag Administration.

The requirements for the design and construction of all features of systems proposed for vessels using gases or other low flashpoint fuels are established in Part 5C, Chapter 13 of the *ABS Rules for Building and Classing Marine Vessels (Marine Vessel Rules)*. It is to be noted that compliance with the applicable edition of the *Marine Vessel Rules* in force at the time the “Alternative Fuel Ready” service is provided does not guarantee compliance with the later edition of the *Marine Vessel Rules* that may be applicable at the time the future conversion to a gas or other low flashpoint fueled ship is actually undertaken.

It is also recognized that at the time of the conversion of a vessel, the arrangements and installations will still be subject to approval by the flag Administrations and the flag Administration may implement the IMO or flag Administration’s requirements in effect at the time of conversion.

This Guide is to be applied to both new construction and existing vessel conversions utilizing gases or other low flashpoint fuels as fuel, regardless of size.

This Guide may be applied to vessels considering all gases or other low flashpoint fuels as fuel covered by the IGF Code, as incorporated in Part 5C, Chapter 13 of the *Marine Vessel Rules*, including, but not limited to:

- Natural Gas (CNG)
- Natural Gas (LNG)
- Ethane
- LPG
- Dimethyl Ether (DME)
- Methanol
- Ethanol
- Hydrogen
- Ammonia

3 Objectives

The objective of this Guide is to define a three (3) level “Alternative Fuel Ready” program, 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 fundamental for defining the readiness of a vessel that is requested to be listed under the “Alternative Fuel Ready” program. A *Level 1 – Concept Design Review* is conducted prior to subsequent application of *Level 2* and *Level 3*. These are briefly described below:

- *Level 1 – Concept Design Review* – This is a high level evaluation of compliance with the *Marine Vessel Rules* of the basic suitability of a particular vessel design to fit a particular gas or other low flashpoint fueled ship concept.
- *Level 2 – Design Review* – Additional to Level 1, it is categorized in separate groups identifying the different parts of the complete design that are design reviewed for compliance with the *Marine Vessel Rules*.
- *Level 3 – Installation* – The final Level of the “Alternative Fuel Ready” program and extends the Class Approval of the drawings to the installation of parts of the system and specified equipment onboard the vessel including Survey in accordance with the related requirements of the *Marine Vessel Rules*.

5 Recognition and Notations

Upon satisfactory completion of each review level, ABS will provide the following recognition of the extent to which compliance with Part 5C, Chapter 13 of the *Marine Vessel Rules* has been established:

- *Level 1* – An Approval in Principle (AIP) for the concept design, and a Record Comment indicating the actual fuels(s) covered by the concept design, will be issued to indicate the Concept Design Review (e.g., “LNG Fuel Ready Level 1”, “LPG Fuel Ready Level 1”, “Methanol Fuel Ready Level 1”).
- *Level 2* – Statement of Compliance with the applicable Rules at the time of review with conditional information required for actual conversion. A Record Comment indicating the actual fuels(s) covered by the design review, will be issued indicating the components or systems for which the design was reviewed, (e.g., “LNG Fuel Ready Level 2”, “Ethane Fuel Ready Level 2”, “LPG and Ammonia Fuel Ready Level 2”).
- *Level 3* – A Class Notation, for example “**LNG Fuel Ready**”, indicating the actual fuels(s) covered by the plan approval and with descriptive letters 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.

The “Alternative Fuel Ready” notations associated with the fuels detailed in 1/1 of this guide are shown under Table 1 and example notations with descriptive letters (see 2/3.1 of this Guide for descriptive letter listing) shown below:

- **LNG Fuel Ready (S, FS, ME, AE)** – For a vessel with approved plans and parts of the system installed in accordance with the requirements of Part 5C, Chapter 13 of the *Marine Vessel Rules* to burn natural gas (Part A-1 of the IGF Code).
- **LPG Fuel Ready (S, FS, ME)** – For a vessel with approved plans and parts of the system installed in accordance with the requirements of Part 5C, Chapter 13 of the *Marine Vessel Rules* to burn LPG and for which the equivalence of the design has been demonstrated by application of the Alternative Design criteria detailed under 5C-13-2/3 of the *Marine Vessel Rules*.
- **Ammonia Fuel Ready (S, ME)** – For a vessel with approved plans and parts of the system installed in accordance with the requirements of Part 5C, Chapter 13 of the *Marine Vessel Rules* to burn ammonia and for which the equivalence of the design has been demonstrated by application of the Alternative Design criteria detailed under 5C-13-2/3 of the *Marine Vessel Rules*.

Notes:

- 1 Where prescriptive IMO requirements exist for particular gases or other low flashpoint fuels, either by regulation, or as interim guidelines, these may be applied in lieu of the Alternative Design criteria detailed under 5C-13-2/3 and subject to agreement by the flag Administration.
- 2 In the future once the vessel has undergone a complete conversion to a gas or low flashpoint fueled vessel that is shown to be in compliance with the *Marine Vessel Rules*, in accordance with approved plans and to the satisfaction of the Surveyor, the above “Alternative Fuel Ready” recognitions or Notations will be dropped and the appropriate Class Notations will be assigned.

TABLE 1
List of “Alternate Fuel ready” Notations

CNG Fuel Ready
LNG Fuel Ready
Ethane Fuel Ready
LPG Fuel Ready
DME Fuel Ready
Methanol Fuel Ready
Ethanol Fuel Ready
Hydrogen Fuel Ready
Ammonia Fuel Ready



SECTION 2 Alternative Fuel Ready Levels

1 Level 1 – Concept Design Review

1.1 Description

The Concept Design Review is a high level evaluation of the basic ability of a vessel design to fit a particular gas or other low flashpoint 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 Part 5C, Chapter 13 of the *Marine Vessel Rules*. Upon satisfactory completion of this review level, ABS will provide an Approval in Principle (AIP) for this concept design and a Record Comment, indicating the actual fuel(s) covered by the concept design, e.g., “LNG Fuel Ready Level 1”, “LPG Fuel Ready Level 1”, “Methanol Fuel Ready Level 1”, to indicate the Concept Design Review.

1.3 Plans and Data to be Submitted

The following plans and documentation are to be submitted, as applicable, for review:

i) Design Specification

Note:

The Design Specification document is to provide an overview of the gas or other low flashpoint fuel concept, providing, but not limited to, high level information on ship arrangements, fuel(s) specification, fuel containment, fuel supply and distribution, consumers, safety systems, design standards and risk assessment methodology.

ii) Fuel Characteristics with details of range of expected properties and composition and, where existing, the associated standards

iii) Risk assessment as referenced by 5C-13-4/2 of the *Marine Vessel Rules*

Note:

Refer to IACS Recommendation No.146 “Risk assessment as required by the IGF Code” for guidance. Depending on the fuel, maturity of design and risk assessment methodology, more detailed risk assessment documentation (e.g., HAZID, HAZOP) may be required for Level 2 Design Review.

iv) General arrangement

v) Fuel storage arrangements

vi) Fuel supply and vapor handling system arrangements

vii) Fuel bunkering station arrangements

viii) Arrangement of machinery space(s) including Gas Valve Unit, consumers and fuel preparation and vapor handling equipment

ix) Hazardous areas classification plan

x) Vent mast and venting arrangements

xi) In addition, for vessels proposing to use gases or other low flashpoint fuels other than natural gas, the following plans and documentation are also to be submitted for review:

Documentation supporting the Alternative Design approval process detailed under 5C-13-2/3 of the *Marine Vessel Rules* and demonstrating that the arrangements meet the intent of the goals and functional requirements of the relevant sections of Part 5C, Chapter 13 to provide an equivalent level of safety.

3 Level 2 – 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.

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 Comment indicating the actual fuel(s) covered by the design review, e.g., “LNG Fuel Ready Level 2”, “Ethane Fuel Ready Level 2”, “LPG and Ammonia Fuel Ready Level 2”, and including descriptive letters will be issued for the components or systems for which the design was reviewed. The reviewed drawings could then be used as part of the future conversion project pending Class and flag State agreement at the time the conversion takes place.

The subgroups of Level 2, as applicable, are:

<i>System/Component</i>	<i>Descriptive Letter(s)</i>
Hull structural reinforcement for fuel storage tank	S
Fuel storage tank arrangements	TA
Fuel bunkering system and arrangement	BK
Fuel supply system	FS
Main engines	ME
Auxiliary engines	AE
Gas turbines	GT
Main or Auxiliary boilers	MB, AB
Fuel cells	FC

The above descriptive letters are to supplement the “Alternative Fuel Ready Level 2” Record Comment when the component or system indicated has been design reviewed (e.g., “LNG Fuel Ready Level 2 (S, TA)”, “Methanol Fuel Ready Level 2 (TA, FS)”).

3.3 Plans and Data to be Submitted

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

Note:

The level of submitted documentation may be reduced by prior agreement where, for example, the design is not fully developed, and a simplified drawing package is prepared for owners to specify instructions to the builder for technical or commercial purposes.

3.3.1 Hull Structural Reinforcement for Fuel Storage Tank (S)

- i) Fuel storage tank type, dimensions, and volume
- ii) Plans of the hull structure in way of the fuel tanks, including the installation of attachments, accessories, internal reinforcements, saddles for support and tie-down devices

- iii) Distribution of the specification, grades and types of steel proposed for the structures of the hull and of the fuel containment system, including attachments, valves, accessories, etc., together with the calculation of the temperatures on all of the structures which can be affected by the low temperatures of the fuel
- iv) Design loads and structural analyses for the fuel storage tank(s) together with complete stress analysis of the hull and fuel containment system

3.3.2 Fuel Storage Tank Structure and Arrangements (TA)

- i) General arrangement of the fuel storage tank(s), and as applicable, hold space/fuel tank storage room, including location of the gas detectors, electrical equipment and lighting
- ii) General arrangement plans of the vessel showing the position of the fuel containment system and details of manholes and other openings in fuel tanks
- iii) Plans of the structure of the fuel containment system, including the installation of attachments, supports and attachment of accessories
- iv) For independent pressure fuel tanks, the standard or Code adopted for the construction and design is to be identified. Detailed construction drawings together with design calculations for the pressure boundary, tank support arrangement and analysis for the load distribution. Anti-collision, chocking arrangement and design calculations
- v) Material specifications for tanks, valves and associated components
- vi) Design loads and structural analyses for the fuel storage tank(s) together with complete stress analysis of the hull and fuel containment system
- vii) Sloshing analysis (where the tank experiences resonance per 5C-12-3/11 and 5C-12-3/5.7 of the *Marine Vessel Rules* or 3/13.9 of the *ABS Guide for Liquefied Gas Carriers with Independent Tanks*, as applicable), in association with 5C-13-6/4.9.4.1.3 of the *Marine Vessel Rules*
- viii) Construction details of submerged fuel pumps including materials specifications
- ix) Diagram of inert-gas systems for tank vapor space or hold-space environmental-control system
- x) Specifications and plans of the insulation system and calculation of the heat balance
- xi) Procedures and calculations of the cooling down and loading operations, including loading limit curve for liquefied gas fuel tanks in accordance with 5C-13-6/8 of the *Marine Vessel Rules*
- xii) Fuel Tank pressure accumulation calculation, in association with the regulations for the maintaining of fuel storage condition, as described in 5C-13-6/9 of the *Marine Vessel Rules*
- xiii) Loading and unloading systems, venting systems, and gas-freeing systems, as well as a schematic diagram of the remote controlled valve system
- xiv) Details and installation of the safety valves and relevant calculations of their relieving capacity, including back pressure
- xv) Gas fuel piping arrangement in way of the fuel tank
- xvi) Details and installation of the various monitoring and control systems, including the devices for measuring the level of the fuel in the tanks and the temperatures in the containment system, and including setpoints for abnormal conditions
- xvii) Fixed gas-detection and alarm systems, and associated shutoff and shutdown systems
- xviii) Schematic diagram of the ventilation system indicating the vent pipe sizes and location of the openings

- xix) Details of the electrical equipment installed in the fuel containment area and of the electrical bonding of the fuel tanks and piping
- xx) Schematic-wiring diagrams
- xxi) Details of fire extinguishing systems
- xxii) Details of testing procedures of fuel tanks and liquid and vapor systems
- xxiii) Welding procedures, stress relieving and non-destructive testing plans
- xxiv) Operating and maintenance instruction manuals, see 5C-13-6/7.2.6, 5C-13-6/3.12, 5C-13-18/2.2 to 5C-13-18/2.4 and 5C-13-18/4.2.1 of the *Marine Vessel Rules*. These are to be submitted for reference purposes only

3.3.3 Fuel Bunkering System and Arrangement (BK)

- i) General arrangement of the fuel bunkering system including location of the gas detectors, electrical equipment and lighting
- ii) Detailed drawings of the bunkering station, manifolds, and valves, couplings and control stations
- iii) Fuel piping systems including piping diagrams and associated components, design pressures, temperatures and insulation
- iv) Material specifications for manifolds, valves and associated components
- v) Weld procedures, stress relieving and non-destructive testing plans
- vi) Bunkering station ventilation system capacity and arrangement
- vii) Fixed gas detection and alarm systems, and associated shut-off and shutdown systems
- viii) Descriptions and schematic diagrams for control and monitoring system including set points for abnormal conditions
- ix) Details of all electrical equipment in the bunkering and control stations
- x) Equipotential bonding and insulating flange arrangement
- xi) Emergency shutdown (ESD) arrangements and ESD flow chart
- xii) Operating and maintenance instruction manuals
- xiii) Testing procedures during sea/gas trials (submitted for survey verification only)

3.3.4 Fuel Supply System (FS)

- i) General arrangement of the fuel preparation room including location of the gas detectors, electrical equipment and lighting
- ii) Doors and other openings in fuel preparation rooms
- iii) Ventilation ducts and system capacity and arrangements for the fuel preparation room
- iv) Details of all fuel handling and fuel supply equipment
- v) Material specifications for compressors, pumps, evaporators, vaporizers, condensers, coolers, heaters, valves and associated components
- vi) Details of all vapor handling equipment (the list of drawings depends on the equipment, and is to be in accordance with 5C-13-6-A2/1.5 (ABS) for reliquefaction systems and/or 5C-13-6-A3/1.3 (ABS) for GCU equipment)
- vii) Capacity and type of means for handling natural boil-off gas together with fuel tank pressure accumulation calculation and details demonstrating compliance with 5C-13-6/9.1 of the *Marine Vessel Rules*
- viii) General arrangement of the re-liquefaction, refrigeration or the GCU compartment

- ix) Ventilation systems capacity and arrangement for the re-liquefaction, refrigeration or the GCU compartment
- x) Fixed gas detection and alarm systems, and associated shut-off and shutdown systems
- xi) Fuel piping systems including details of piping and associated components (including safety and block valves units), design pressures, temperatures, insulation, drip trays and shielding
- xii) Weld procedures, stress relieving and non-destructive testing plans
- xiii) Fuel gas compressors and pumps, with details such as type and size
- xiv) Vaporizers/heaters
- xv) Pressure vessels
- xvi) Descriptions and schematic diagrams for control and monitoring system including set points for abnormal conditions
- xvii) Details of all electrical equipment in the fuel supply room
- xviii) Electric bonding (earthing) arrangement
- xix) Failure Modes and Effects Analysis (FMEA) to determine possible failures and their effects in the safe operation of the fuel supply system
- xx) Emergency shutdown arrangements
- xxi) Fuel supply system diagram from the tanks to the consumers
- xxii) Operating and maintenance instruction manuals
- xxiii) Testing procedures during sea/gas trials (submitted for survey verification only)

3.3.5 Consumers (Engines (**ME, AE**), Boilers (**MB, AB**), Gas Turbines (**GT**), Fuel Cells (**FC**) and Auxiliaries)

- i) General arrangements showing location of the power generation equipment and other fuel consumers installed for propulsion and auxiliary purposes
- ii) The list of drawings to be submitted depends on the selected consumers, and it is to be in accordance with 5C-13-10/1 (ABS), 5C-13-10A1/5 (ABS) or 4-4-1/1.13.1 of the *Marine Vessel Rules*

5 Level 3 – Installation

5.1 Description

This is the final Level of the “Alternative Fuel Ready” program and extends the Class Approval of the drawings to 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 2 approved drawings are to be in compliance with the relevant sections of Part 5C, Chapter 13 of the *Marine Vessel Rules*. Upon completion of the installation to the Surveyor’s satisfaction, the vessel will be eligible for class notation indicating the actual fuel(s) covered by the design approval and installation, for example, **LNG Fuel Ready**, **Methanol Fuel Ready**, etc., including descriptive letters for the component or systems that have been installed in accordance with the approved plans. The survey of equipment at the manufacturers, during installation and the survey intervals thereafter are covered in 2/5.5 below.

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

The descriptive letters are to supplement the class notation when the component 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 (e.g., **LNG Fuel Ready (S, FS, ME)**, **Methanol Fuel Ready (TA, BK, FS)**, **LPG and Ammonia Fuel Ready (S, ME)**, etc.). For those instances when only part of a

system is installed the applicable descriptive letter with appended brief description to indicate the installed equipment will be included. Some examples are:

- **FS** fuel gas piping
- **BK** manifold
- **MB** Dual Fuel main boiler

5.3 Plans and Data to be Submitted

The plans and documents associated with Level 3 vessel modification and equipment installation are listed above under 2/3.3 of this 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 Part 5C, Chapter 13 of the *Marine Vessel Rules*, as applicable.

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, as applicable, in Sections 7-3-2 and 7-6-2 of the *ABS Rules for Survey After Construction (Part 7)*.