



GUIDELINES FOR ALTERNATIVE FUEL READY SHIPS

CR CLASSIFICATION SOCIETY

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CHAPTER 1 General

1.1 Scope and Application

1.1.1 CR Guidelines for Alternative Fuel Ready Ships (hereinafter referred to as the Guidelines) are applied to ships 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.

1.1.2 The requirements for the design and construction of all features of systems proposed for ships using gases or other low flashpoint fuels are established in CR Guidelines for Ships Using Gases or other Low-Flashpoint Fuels (hereinafter referred to as "the CR LFFS Guidelines"), CR Guidelines for Ships Using Ammonia as Fuel (hereinafter referred to as "the CR AFS Guidelines") and CR Guidelines for Ships Using Methanol (Methyl Alcohol) and Ethanol (Ethyl Alcohol) Fuels (hereinafter referred to as "the CR MFS Guidelines"). It is to be noted that compliance with the applicable edition of the CR Rules and Guidelines in force at the time the "Alternative Fuel Ready" service is provided does not guarantee compliance with the later edition of the CR Rules and Guidelines that may be applicable at the time the future conversion to a gas or other low flashpoint fueled ship is actually undertaken.

1.1.3 The Guidelines are 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 (hereinafter referred to as "the IGC Code ") and the CR Guidelines for Ships Carrying Liquefied Gases in Bulk (hereinafter referred to as "the CR LGC Guidelines ") and burning their cargo as fuel. It applies to such ships 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:

CR Classification Society (hereinafter referred to as "the Society") will consider application of the "Alternative Fuel Ready" program and notations of the Guidelines 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 the CR LGC Guidelines and with agreement of the flag Administration.

1.1.4 It is recognized that at the time of the conversion of a ship, 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.

1.1.5 The Guidelines are to be applied to both new construction and existing ship conversions utilizing gases or other low flashpoint fuels as fuel, regardless of size.

The Guidelines may be applied to ships considering all gases or other low flashpoint fuels as fuel covered by the International Code of Safety for Ships Using Gases or Other Low-flashpoint Fuels (hereinafter referred to as "the IGF Code"), as incorporated in the CR LFFS Guidelines but not limited to:

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

1.2 Objectives

The objectives of the Guideline are to define a 3 level "Alternative Fuel Ready" program, to provide the details and preparations needed for each Level, and to describe the notations that the Society will offer subject to compliance of the requirements at each Level.

There are 3 Levels considered fundamental for defining the readiness of a ship 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:

1.2.1 Level 1: concept design review

This is a high level evaluation of compliance with the CR Rules and Guidelines of the basic suitability of a particular ship design to be able to fit a particular gas or other low flashpoint fueled ship concept.

1.2.2 Level 2: detail 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 CR Rules and Guidelines.

1.2.3 Level 3: installation

The final Level of the "Alternative Fuel Ready" program and extends the plan approval to the installation of parts of the system and specified equipment onboard the ship including survey in accordance with the related requirements of the CR Rules and Guidelines.

1.3 Class Notations

Upon satisfactory completion of each review level, the Society will provide the following recognition of the extent to which compliance with the CR LFFS Guidelines has been established:

1.3.1 **Alternative Fuel Ready-I** for Level 1 : Concept Design Review

A design-based class notation, for example **Ammonia Fuel Ready-I**, assigned upon satisfactory review of the concept design for Level 1 compliance in accordance with 2.1 of the Guidelines. This notation indicates the actual fuels(s) covered by the concept design and the basic ability of a ship design to fit a particular gas or other low flashpoint fuel.

The "**Alternative Fuel Ready-I**" notations associated with the fuels detailed in 1.1 of the Guidelines are to be assigned when those fuels are covered in the concept design review. Example notations are shown below:

- **LNG Fuel Ready-I**
- **Methanol Fuel Ready-I**

or a combined notation detailing designs compatible for multi fuels, as applicable

- **LPG and Ammonia Fuel Ready-I**

1.3.2 **Alternative Fuel Ready-II** for Level 2 : Detail Design Review

A design-based class notation, for example **Ammonia Fuel Ready-II**, assigned upon satisfactory review of the detail design for Level 2 compliance in accordance with 2.2 of the Guidelines. This notation indicates the actual fuels(s) covered by the detail design review and the components or systems for which the design was reviewed.

The "**Alternative Fuel Ready-II**" notations associated with the fuels detailed in 1.1 of the Guidelines are to be assigned when those fuels are covered in the detail design review. Example notations with descriptive letters (see 2.2.1 of the Guidelines for descriptive letter listing) are shown below:

(a) **LNG Fuel Ready-II (S, FS, ME, AE)**

For a ship with approved plans in accordance with the requirements of the CR LFFS Guidelines to burn natural gas (Part A-1 of the IGF Code).

(b) **Ammonia Fuel Ready-II (S, ME)**

For a ship with approved plans in accordance with the requirements of the CR LFFS Guidelines to burn ammonia and for which the equivalence of the design has been demonstrated by application of the alternative design criteria detailed under 2.3 of the CR AFS Guidelines.

(c) **LPG Fuel Ready-II (S, FS, ME)**

For a ship with approved plans in accordance with the requirements of the CR LFFS Guidelines to burn LPG and for which the equivalence of the design has been demonstrated by application of the alternative design criteria detailed under 2.3 of the CR LFFS Guidelines.

1.3.3 **Alternative Fuel Ready-III for Level 3 : Installation**

A class notation, for example "**LNG Fuel Ready-III**", 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 ship.

The "**Alternative Fuel Ready-III**" notations associated with the fuels detailed in 1.1 of the Guidelines are to be assigned when those fuels are covered in the installation of specified equipment onboard the ship. Example notations with descriptive letters (see 2.3.1 of the Guidelines for descriptive letter listing) are shown below:

(a) **LNG Fuel Ready-III (S, FS, ME, AE)**

For a ship with approved plans and parts of the system installed in accordance with the requirements of the CR LFFS Guidelines to burn natural gas (Part A-1 of the IGF Code).

(b) **LPG Fuel Ready-III (S, FS, ME)**

For a ship with approved plans and parts of the system installed in accordance with the requirements of the CR LFFS Guidelines to burn LPG and for which the equivalence of the design has been demonstrated by application of the alternative design criteria detailed under 2.3 of the CR LFFS Guidelines.

(c) **Ammonia Fuel Ready-III (S, ME)**

For a ship with approved plans and parts of the system installed in accordance with the requirements of the CR LFFS Guidelines to burn ammonia and for which the equivalence of the design has been demonstrated by application of the alternative design criteria detailed under 2.3 of the CR AFS Guidelines.

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 2.3 of the CR LFFS Guidelines and subject to agreement by the Flag Administration.
- (2) In the future once the ship has undergone a complete conversion to a gas or low flashpoint fueled ship that is shown to be in compliance with the CR Rules and Guidelines, in accordance with approved plans and to the satisfaction of the Surveyor, the above "**Alternative Fuel Ready-III**" notations will be dropped and the appropriate class notations will be assigned.

CHAPTER 2 Alternative Fuel Ready Levels

2.1 Level 1 – Concept Design Review

2.1.1 Description

The concept design review is a high level evaluation of the basic ability of a ship 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 ship 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 CR LFFS Guidelines. Upon satisfactory completion of this review level, the Society will assign a class notation, indicating the actual fuel(s) covered by the concept design, e.g., "**LNG Fuel Ready-I**", "**Methanol Fuel Ready-I**", "**Ammonia Fuel Ready-I**", to indicate the concept design review.

2.1.2 Plans and data to be submitted

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

(a) 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.

(b) Fuel characteristics with details of range of expected properties and composition and, where existing, the associated standards

(c) Risk assessment as referenced by 4.2 of the CR LFFS Guidelines.

Note:

- (1) Refer to IACS Recommendation No.146 "Risk assessment as required by the IGF Code" for guidance.
- (2) In lieu of a full risk assessment for Level 1, a safety concept document addressing all potential risks as far as practicably possible may substitute the risk assessment and may be included in the design specification document. The safety concept document is to include a list of potential risks and countermeasures to be applied. In those instances, more detailed risk assessment documentation will be required for Level 2 reviews. See also note (1) to 2.2.2 of the Guidelines.

(d) General arrangement

(e) Fuel storage arrangements

(f) Fuel supply and vapor handling system arrangements

(g) Fuel bunkering station arrangements

(h) Arrangement of machinery space(s) including gas valve unit, consumers and fuel preparation and vapor handling equipment

- (i) Hazardous areas classification plan
- (j) Vent mast and venting arrangements
- (k) In addition, for ships 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 2.3 of the CR LFFS Guidelines and demonstrating that the arrangements meet the intent of the goals and functional requirements of the relevant sections of the CR LFFS Guidelines to provide an equivalent level of safety.

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 2.3 of the CR LFFS Guidelines and subject to agreement by the flag Administration; e.g. MSC.1/Circ.1621, the Interim Guidelines for the Safety of Ships Using Methyl/Ethyl Alcohol as Fuels.

2.2 Level 2 – Detail Design Review

2.2.1 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, the Society will assign a class notation indicating the actual fuel(s) covered by the design review, e.g., "**LNG Fuel Ready-II**", "**Ethane Fuel Ready-II**", "**LPG and Ammonia Fuel Ready-II**" including descriptive letters 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 are as given in the following table:

**Table 2-1
 System/Component and Descriptive Letters**

System/Component	Descriptive letters
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-II**" notation when the component or system indicated has been design reviewed (e.g., "**LNG Fuel Ready-II (S, TA)**", "**Methanol Fuel Ready-II (TA, FS)**").

2.2.2 Plans and data to be submitted

In addition to the documentation submitted for Level 1, the plans and documents to be submitted for each group of Level 2, as applicable, are listed below.

Note:

- (1) Depending on the fuel and the maturity of design, the risk assessment and alternative design documentation submitted for Level 1 may only be appropriate for the concept design review, or preliminary design basis. In those instances, more detailed risk assessment documentation will be required for Level 2 reviews.
- (2) The level of submitted documentation may be reduced by prior agreement where, for example, the design is not fully developed or based on the characteristics of the alternative fuel (refer to the CR AFS Guidelines and the CR MFS Guidelines), and a simplified drawing package is prepared for owners to specify instructions to the builder for technical or commercial purposes.
 - (a) 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
 - (b) 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 ship 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, in association with 6.4.9.4.1.3 of the CR LFFS Guidelines and 4.14.3 of the CR LGC Guidelines
 - (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 6.8 of the CR LFFS Guidelines.
 - (xii) Fuel tank pressure accumulation calculation, in association with the regulations for the maintaining of fuel storage condition, as described in 6.9 of the CR LFFS Guidelines.
 - (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 shut-off 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 6.7.2.6, 6.3.12, 18.2.2 to 18.2.4 and 18.4.2.1 of the CR LFFS Guidelines. These are to be submitted for reference purposes only
- (c) 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) Welding 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 shutoff and shutdown systems
 - (viii) Descriptions and schematic diagrams for control and monitoring system including setpoints 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)
- (d) 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 Annex 2/1.4 of the CR LFFS Guidelines for reliquefaction systems and/or Annex 3/1.3 of the CR LFFS Guidelines for Gas Combustion Units (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 6.9.1 of the CR LFFS Guidelines.
 - (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 shutoff 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) Welding 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 setpoints 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)
- (e) 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 accordance with 10.1 and Annex 5/5 of the CR LFFS Guidelines.

Note:

Only engines types that are CR type approved as dual fuel or single alternative fuel engines, and therefore readily convertible for gas or other low-flashpoint fuel operation, will be eligible for the **ME** or **AE** descriptive letters.

2.3 Level 3 – Installation

2.3.1 Description

This is the final Level of the "Alternative Fuel Ready" program and extends the plan approval 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 the CR LFFS Guidelines. Upon completion of the installation to the Surveyor's satisfaction, the ship will be eligible for class notation indicating the actual fuel(s) covered by the design approval and installation, for example, **LNG Fuel Ready-III**, **Methanol Fuel Ready-III**, 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 2.3.3 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 approved and/or surveyed by the Society as per the applicable Rules and Guidelines requirements and installed on board to the attending Surveyor's satisfaction (e.g., **LNG Fuel Ready-III (S, FS, ME)**, **Methanol Fuel Ready-III (TA, BK, FS)**, **LPG and Ammonia Fuel Ready-III (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 compressors and pumps
- **BK** : bunkering manifolds
- **ME** : dual fuel main engine

CHAPTER 2 Alternative Fuel Ready Levels

2.3 Level 3 – Installation

2.3.2 Plans and data to be submitted

The plans and documents associated with Level 3 ship modification and equipment installation are listed above under 2.2.2 of the Guidelines.

2.3.3 Survey

(a) Material and equipment inspection

The components or systems specified in the "Alternative Fuel Ready" program and intended to be installed on-board are to be inspected in accordance with the applicable requirements in CR Rules and Guidelines, such as CR Guidelines for Survey of Products for Marine Use, the CR LFFS Guidelines, the CR AFS Guidelines, the CR MFS Guidelines and the CR Rules for Steel Ships, etc.

(b) Survey during installation

During installation of the specified components or systems for the "Alternative Fuel Ready" program, the installation survey is to be carried out in the presence of the Surveyor of the Society.

(c) Survey after construction

The survey after installation of the specified components or systems for the "Alternative Fuel Ready" program will be included in Annual Survey and Special Survey in accordance with Part I of the CR Rules for Steel Ships, as applicable.