



**BUREAU  
VERITAS**

# **LPG-Fuelled Ships – Tentative Rules**

**January 2018**

**Guidance Note  
NI 647 DT R00 E**

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**BUREAU  
VERITAS**

# MARINE & OFFSHORE - GENERAL CONDITIONS

## 1. INDEPENDENCY OF THE SOCIETY AND APPLICABLE TERMS

- 1.1. The Society shall remain at all times an independent contractor and neither the Society nor any of its officers, employees, servants, agents or subcontractors shall be or act as an employee, servant or agent of any other party hereto in the performance of the Services.
- 1.2. The operations of the Society in providing its Services are exclusively conducted by way of random inspections and do not, in any circumstances, involve monitoring or exhaustive verification.
- 1.3. The Society acts as a services provider. This cannot be construed as an obligation bearing on the Society to obtain a result or as a warranty. The Society is not and may not be considered as an underwriter, broker in Unit's sale or chartering, expert in Unit's valuation, consulting engineer, controller, naval architect, manufacturer, shipbuilder, repair or conversion yard, charterer or shipowner; none of them above listed being relieved of any of their expressed or implied obligations as a result of the interventions of the Society.
- 1.4. The Services are carried out by the Society according to the applicable Rules and to the Bureau Veritas' Code of Ethics. The Society only is qualified to apply and interpret its Rules.
- 1.5. The Client acknowledges the latest versions of the Conditions and of the applicable Rules applying to the Services' performance.
- 1.6. Unless an express written agreement is made between the Parties on the applicable Rules, the applicable Rules shall be the rules applicable at the time of the Services' performance and contract's execution.
- 1.7. The Services' performance is solely based on the Conditions. No other terms shall apply whether express or implied.

## 2. DEFINITIONS

- 2.1. "**Certificate(s)**" means class certificates, attestations and reports following the Society's intervention. The Certificates are an appraisal given by the Society to the Client, at a certain date, following surveys by its surveyors on the level of compliance of the Unit to the Society's Rules or to the documents of reference for the Services provided. They cannot be construed as an implied or express warranty of safety, fitness for the purpose, seaworthiness of the Unit or of its value for sale, insurance or chartering.
- 2.2. "**Certification**" means the activity of certification in application of national and international regulations or standards, in particular by delegation from different governments that can result in the issuance of a certificate.
- 2.3. "**Classification**" means the classification of a Unit that can result or not in the issuance of a class certificate with reference to the Rules.
- 2.4. "**Client**" means the Party and/or its representative requesting the Services.
- 2.5. "**Conditions**" means the terms and conditions set out in the present document.
- 2.6. "**Industry Practice**" means International Maritime and/or Offshore industry practices.
- 2.7. "**Intellectual Property**" means all patents, rights to inventions, utility models, copyright and related rights, trade marks, logos, service marks, trade dress, business and domain names, rights in trade dress or get-up, rights in goodwill or to sue for passing off, unfair competition rights, rights in designs, rights in computer software, database rights, topography rights, moral rights, rights in confidential information (including know-how and trade secrets), methods and protocols for Services, and any other intellectual property rights, in each case whether capable of registration, registered or unregistered and including all applications for and renewals, reversions or extensions of such rights, and all similar or equivalent rights or forms of protection in any part of the world.
- 2.8. "**Parties**" means the Society and Client together.
- 2.9. "**Party**" means the Society or the Client.
- 2.10. "**Register**" means the register published annually by the Society.
- 2.11. "**Rules**" means the Society's classification rules, guidance notes and other documents. The Rules, procedures and instructions of the Society take into account at the date of their preparation the state of currently available and proven technical minimum requirements but are not a standard or a code of construction neither a guide for maintenance, a safety handbook or a guide of professional practices, all of which are assumed to be known in detail and carefully followed at all times by the Client.
- 2.12. "**Services**" means the services set out in clauses 2.2 and 2.3 but also other services related to Classification and Certification such as, but not limited to: ship and company safety management certification, ship and port security certification, training activities, all activities and duties incidental thereto such as documentation on any supporting means, software, instrumentation, measurements, tests and trials on board.
- 2.13. "**Society**" means the classification society "**Bureau Veritas Marine & Offshore SAS**", a company organized and existing under the laws of France, registered in Nanterre under the number 821 131 844, or any other legal entity of Bureau Veritas Group as may be specified in the relevant contract, and whose main activities are Classification and Certification of ships or offshore units.
- 2.14. "**Unit**" means any ship or vessel or offshore unit or structure of any type or part of it or system whether linked to shore, river bed or sea bed or not, whether operated or located at sea or in inland waters or partly on land, including submarines, hovercrafts, drilling rigs, offshore installations of any type and of any purpose, their related and ancillary equipment, subsea or not, such as well head and pipelines, mooring legs and mooring points or otherwise as decided by the Society.

## 3. SCOPE AND PERFORMANCE

- 3.1. The Society shall perform the Services according to the applicable national and international standards and Industry Practice and always on the assumption that the Client is aware of such standards and Industry Practice.

- 3.2. Subject to the Services performance and always by reference to the Rules, the Society shall:

- review the construction arrangements of the Unit as shown on the documents provided by the Client;
- conduct the Unit surveys at the place of the Unit construction;
- class the Unit and enters the Unit's class in the Society's Register;
- survey the Unit periodically in service to note that the requirements for the maintenance of class are met. The Client shall inform the Society without delay of any circumstances which may cause any changes on the conducted surveys or Services.

The Society will not:

- declare the acceptance or commissioning of a Unit, nor its construction in conformity with its design, such activities remaining under the exclusive responsibility of the Unit's owner or builder;
- engage in any work relating to the design, construction, production or repair checks, neither in the operation of the Unit or the Unit's trade, neither in any advisory services, and cannot be held liable on those accounts.

## 4. RESERVATION CLAUSE

- 4.1. The Client shall always: (i) maintain the Unit in good condition after surveys; (ii) present the Unit after surveys; (iii) present the Unit for surveys; and (iv) inform the Society in due course of any circumstances that may affect the given appraisal of the Unit or cause to modify the scope of the Services.

- 4.2. Certificates referring to the Society's Rules are only valid if issued by the Society.

- 4.3. The Society has entire control over the Certificates issued and may at any time withdraw a Certificate at its entire discretion including, but not limited to, in the following situations: where the Client fails to comply in due time with instructions of the Society or where the Client fails to pay in accordance with clause 6.2 hereunder.

## 5. ACCESS AND SAFETY

- 5.1. The Client shall give to the Society all access and information necessary for the efficient performance of the requested Services. The Client shall be the sole responsible for the conditions of presentation of the Unit for tests, trials and surveys and the conditions under which tests and trials are carried out. Any information, drawings, etc. required for the performance of the Services must be made available in due time.

- 5.2. The Client shall notify the Society of any relevant safety issue and shall take all necessary safety-related measures to ensure a safe work environment for the Society or any of its officers, employees, servants, agents or subcontractors and shall comply with all applicable safety regulations.

## 6. PAYMENT OF INVOICES

- 6.1. The provision of the Services by the Society, whether complete or not, involve, for the part carried out, the payment of fees thirty (30) days upon issuance of the invoice.

- 6.2. Without prejudice to any other rights hereunder, in case of Client's payment default, the Society shall be entitled to charge, in addition to the amount not properly paid, interests equal to twelve (12) months LIBOR plus two (2) per cent as of due date calculated on the number of days such payment is delinquent. The Society shall also have the right to withhold certificates and other documents and/or to suspend or revoke the validity of certificates.

- 6.3. In case of dispute on the invoice amount, the undisputed portion of the invoice shall be paid and an explanation on the dispute shall accompany payment so that action can be taken to solve the dispute.

## 7. LIABILITY

- 7.1. The Society bears no liability for consequential loss. For the purpose of this clause consequential loss shall include, without limitation:

- Indirect or consequential loss;
- Any loss and/or deferral of production, loss of product, loss of use, loss of bargain, loss of revenue, loss of profit or anticipated profit, loss of business and business interruption, in each case whether direct or indirect.

The Client shall save, indemnify, defend and hold harmless the Society from the Client's own consequential loss regardless of cause.

- 7.2. In any case, the Society's maximum liability towards the Client is limited to one hundred and fifty per-cents (150%) of the price paid by the Client to the Society for the performance of the Services. This limit applies regardless of fault by the Society, including breach of contract, breach of warranty, tort, strict liability, breach of statute.

- 7.3. All claims shall be presented to the Society in writing within three (3) months of the Services' performance or (if later) the date when the events which are relied on were first discovered by the Client. Any claim not so presented as defined above shall be deemed waived and absolutely time barred.

## 8. INDEMNITY CLAUSE

- 8.1. The Client agrees to release, indemnify and hold harmless the Society from and against any and all claims, demands, lawsuits or actions for damages, including legal fees, for harm or loss to persons and/or property tangible, intangible or otherwise which may be brought against the Society, incidental to, arising out of or in connection with the performance of the Services except for those claims caused solely and completely by the negligence of the Society, its officers, employees, servants, agents or subcontractors.

## 9. TERMINATION

- 9.1. The Parties shall have the right to terminate the Services (and the relevant contract) for convenience after giving the other Party thirty (30) days' written notice, and without prejudice to clause 6 above.

- 9.2. In such a case, the class granted to the concerned Unit and the previously issued certificates shall remain valid until the date of effect of the termination notice issued, subject to compliance with clause 4.1 and 6 above.

## 10. FORCE MAJEURE

- 10.1. Neither Party shall be responsible for any failure to fulfil any term or provision of the Conditions if and to the extent that fulfilment has been delayed or temporarily prevented by a force majeure occurrence without the fault or negligence of the Party affected and which, by the exercise of reasonable diligence, the said Party is unable to provide against.

- 10.2. For the purpose of this clause, force majeure shall mean any circumstance not being within a Party's reasonable control including, but not limited to: acts of God, natural disasters, epidemics or pandemics, wars, terrorist attacks, riots, sabotages, impositions of sanctions, embargoes, nuclear, chemical or biological contaminations, laws or action taken by a government or public authority, quotas or prohibition, expropriations, destructions of the worksite, explosions, fires, accidents, any labour or trade disputes, strikes or lockouts

## 11. CONFIDENTIALITY

- 11.1. The documents and data provided to or prepared by the Society in performing the Services, and the information made available to the Society, are treated as confidential except where the information:

- is already known by the receiving Party from another source and is properly and lawfully in the possession of the receiving Party prior to the date that it is disclosed;
- is already in possession of the public or has entered the public domain, otherwise than through a breach of this obligation;
- is acquired independently from a third party that has the right to disseminate such information;
- is required to be disclosed under applicable law or by a governmental order, decree, regulation or rule or by a stock exchange authority (provided that the receiving Party shall make all reasonable efforts to give prompt written notice to the disclosing Party prior to such disclosure).

- 11.2. The Society and the Client shall use the confidential information exclusively within the framework of their activity underlying these Conditions.

- 11.3. Confidential information shall only be provided to third parties with the prior written consent of the other Party. However, such prior consent shall not be required when the Society provides the confidential information to a subsidiary.

- 11.4. The Society shall have the right to disclose the confidential information if required to do so under regulations of the International Association of Classifications Societies (IACS) or any statutory obligations.

## 12. INTELLECTUAL PROPERTY

- 12.1. Each Party exclusively owns all rights to its Intellectual Property created before or after the commencement date of the Conditions and whether or not associated with any contract between the Parties.

- 12.2. The Intellectual Property developed for the performance of the Services including, but not limited to drawings, calculations, and reports shall remain exclusive property of the Society.

## 13. ASSIGNMENT

- 13.1. The contract resulting from these Conditions cannot be assigned or transferred by any means by a Party to a third party without the prior written consent of the other Party.

- 13.2. The Society shall however have the right to assign or transfer by any means the said contract to a subsidiary of the Bureau Veritas Group.

## 14. SEVERABILITY

- 14.1. Invalidity of one or more provisions does not affect the remaining provisions.

- 14.2. Definitions herein take precedence over other definitions which may appear in other documents issued by the Society.

- 14.3. In case of doubt as to the interpretation of the Conditions, the English text shall prevail.

## 15. GOVERNING LAW AND DISPUTE RESOLUTION

- 15.1. The Conditions shall be construed and governed by the laws of England and Wales.

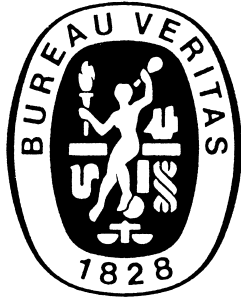
- 15.2. The Society and the Client shall make every effort to settle any dispute amicably and in good faith by way of negotiation within thirty (30) days from the date of receipt by either one of the Parties of a written notice of such a dispute.

- 15.3. Failing that, the dispute shall finally be settled by arbitration under the LCIA rules, which rules are deemed to be incorporated by reference into this clause. The number of arbitrators shall be three (3). The place of arbitration shall be London (UK).

## 16. PROFESSIONAL ETHICS

- 16.1. Each Party shall conduct all activities in compliance with all laws, statutes, rules, and regulations applicable to such Party including but not limited to: child labour, forced labour, collective bargaining, discrimination, abuse, working hours and minimum wages, anti-bribery, anti-corruption. Each of the Parties warrants that neither it, nor its affiliates, has made or will make, with respect to the matters provided for hereunder, any offer, payment, gift or authorization of the payment of any money directly or indirectly, to or for the use or benefit of any official or employee of the government, political party, official, or candidate.

- 16.2. In addition, the Client shall act consistently with the Society's Code of Ethics of Bureau Veritas. <http://www.bureauveritas.com/home/about-us/ethics+and+compliance/>



## GUIDANCE NOTE NI 647

# LPG-Fuelled Ships - Tentative Rules

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### SECTION 1    LPG-FUELLED SHIPS

## Section 1 LPG-Fuelled Ships

<b>1</b>	<b>Introduction</b>	<b>5</b>
1.1	Use of LPG as fuel	
1.2	LPG and gas properties	
1.3	Main safety aspects	
<b>2</b>	<b>Application</b>	<b>5</b>
2.1	Scope	
2.2	Documents to be submitted	
2.3	Classification	
2.4	Definitions	
<b>3</b>	<b>General design principles</b>	<b>7</b>
3.1	General functional requirements	
3.2	Limitation of explosion consequences	
3.3	Risk assessment	
<b>4</b>	<b>Ship design and arrangements</b>	<b>8</b>
4.1	Functional requirements	
4.2	Design and arrangement of LPG tanks	
4.3	Arrangement of machinery spaces	
4.4	Location and protection of fuel piping	
4.5	LPG preparation room	
4.6	Regulations for bilge systems and drainage arrangements	
4.7	Drip trays	
4.8	Regulations for access to hazardous areas	
4.9	Venting arrangements	
<b>5</b>	<b>Fuel containment system</b>	<b>10</b>
5.1	General	
5.2	Operating conditions of the storage tank	
5.3	Tank pressure relief systems	
<b>6</b>	<b>Material and general pipe design</b>	<b>10</b>
6.1	General	
6.2	Functional requirements	
6.3	Materials	
6.4	Prevention of phase changes in LPG supply lines	
<b>7</b>	<b>Bunkering</b>	<b>10</b>
7.1	General	
7.2	Arrangement of the bunkering station	
<b>8</b>	<b>Fuel supply to consumers</b>	<b>10</b>
8.1	General	
8.2	Secondary enclosure for LPG fuel piping	
<b>9</b>	<b>Power generation including propulsion and other LPG consumers</b>	<b>11</b>
9.1	General	
9.2	Diesel engines	
9.3	Gas Turbine	

<b>10</b>	<b>Fire safety and explosion prevention</b>	<b>11</b>
	10.1 General	
<b>11</b>	<b>Ventilation</b>	<b>11</b>
	11.1 General	
	11.2 Arrangement of the ventilation systems serving hazardous spaces	
<b>12</b>	<b>Electrical installations</b>	<b>12</b>
	12.1 General	
	12.2 Electrical equipment for hazardous areas	
<b>13</b>	<b>Control, monitoring and safety systems</b>	<b>12</b>
	13.1 General	
	13.2 Regulation for gas detection	
<b>14</b>	<b>Manufacture, workmanship and testing</b>	<b>12</b>
	14.1 General	



# SECTION 1

# LPG-FUELLED SHIPS

## 1 Introduction

### 1.1 Use of LPG as fuel

**1.1.1** The use of LPG as ship fuel may be decided for different reasons, such as:

- environmental compliance (reduction of NO<sub>x</sub>, CO<sub>2</sub> and particle emissions, elimination of SO<sub>x</sub> emissions) in particular when stricter regulations are enforced
- economic reasons (LPG prices vs fuel oil prices)
- availability reasons (extent of the LPG supply network).

### 1.2 LPG and gas properties

#### 1.2.1 LPG Composition

LPG is a predominant mixture of propane and butane (normal and iso-butane) with a small percentage of unsaturated hydrocarbons (ethylene, propylene and butylene) and traces of lighter hydrocarbons (ethane) as well as heavier hydrocarbons (pentane).

LPG composition depends on the source from which LPG gas is produced (crude oil and natural gas production fields or oil refining). In most places in the world LPG is propane while in other places it consists of butane or a mixture of both propane and butane.

The composition of the liquid phase and vapour phase depends on the pressure. It can be obtained from the equilibrium diagram for propane/butane mixtures at the considered pressure.

#### 1.2.2 LPG boiling temperature

LPG has a boiling temperature depending on composition and usually ranging from – 42 °C (pure propane) to – 0,5 °C (pure n-butane) at atmospheric pressure.

#### 1.2.3 Vapour pressure

LPG has a vapour pressure depending on composition and ranging from:

- 1,8 bar (pure n-butane) to 7,3 bar (pure propane) at 15°C
  - 4,3 bar (pure n-butane) to 15,3 bar (pure propane) at 45°C
- Density of gaseous LPG.

#### 1.2.4 Density of gaseous LPG

The density of gaseous LPG depends on the composition and usually ranges from:

- 1,89 kg/m<sup>3</sup> (pure propane) to 2,54 kg/m<sup>3</sup> (pure n-butane) at a temperature of 15°C and atmospheric pressure
- 1,69 kg/m<sup>3</sup> (pure propane) to 2,25 kg/m<sup>3</sup> (pure n-butane) at a temperature of 45°C and atmospheric pressure.

The above figures are to be compared to the density of air at atmospheric pressure: 1,22 kg/m<sup>3</sup> at 15°C and 1,11 kg/m<sup>3</sup> at 45°C. Gaseous LPG is much heavier than air and hence, in case of leakage in a space, it settles down at low points.

#### 1.2.5 Flammability

The flammability characteristics of gaseous LPG are as follows:

- FLF (Lower flammability limit) by volume in air: between 1,4 (n-butane) and 1,7% (propane) according to EN1839
- ULF (Upper flammability limit) by volume in air: between 9,4% (n-butane) and 10,8% (propane) according to EN1839
- auto-ignition temperature (EN 14522): between 392°C (n-butane) and 459°C (propane), higher than that of MGO (300°C)
- minimum ignition energy: 0,25 mJ, lower than that of many hydrocarbons.

### 1.3 Main safety aspects

**1.3.1** The main safety aspects associated with the use of LPG as fuel include:

- risk of fire and explosion after vaporization of liquid LPG into a gaseous state
- risk of asphyxiation induced by high concentrations of LPG gas since it displaces the oxygen in the air.

## 2 Application

### 2.1 Scope

**2.1.1** The purpose of these Guidelines is to provide a set of functional requirements and detailed design and installation requirements for the classification of ships using LPG as fuel, other than vessels covered by the IGC Code.

These Guidelines may however be applied to LPG carriers in addition to the provisions of NR467, Part D, Chapter 9, which take precedence over the provisions of these Guidelines.

**2.1.2** Except as otherwise stated in this document, it applies to all types of ships.

**2.1.3** These Guidelines cover the arrangement, installation, control and monitoring of machinery, equipment and systems using LPG to minimize the risk to the ship, its crew and the environment.

**2.1.4** These Guidelines cover only LPG-fuelled installations where LPG is stored in type C tanks, in liquefied state under pressure at temperatures down to – 42°C. LPG may be used at high pressure in liquid state or low pressure in gaseous state.

### 2.2 Documents to be submitted

**2.2.1** The documents to be submitted to the Society are listed in Tab 1.

**Table 1 : Documents to be submitted**

No.	A/I (1)	Documents
1	A	General arrangement of the ship showing the location of the bunkering stations, LPG tanks, tank connection spaces, fuel preparation rooms , vent masts, etc
2	A	General arrangement of the machinery spaces containing the gas utilization units (engines, gas turbines, boilers and gas combustion units)
3	A	Gas-dangerous zone plan
4	A	Air locks between safe and dangerous zones
5	A	Risk analysis as per 3.3 and 9.2.3
6	A	Arrangement of tanks supports, saddles, anti-floating and anti-lifting devices, deck sealing arrangements, etc
7	A	Scantlings, material and arrangement of the LPG tanks
8	A	Sloshing calculation where relevant
9	A	Stress analysis of the tanks, including fatigue analysis and crack propagation analysis where required
10	A	Details of LPG tank domes and deck sealings
11	A	Testing and inspection procedures for LPG tank manufacturing
12	A	In-service inspection/survey plan for the LPG tanks
13	A	Vent mast detailed drawing
14	A	LPG fuel tank pressure control principle
15	A	Plans and calculation of safety relief valves
16	A	Diagram of the liquefied and gaseous LPG fuel piping system, including venting system
17	A	Arrangement of the double piping or duct system
18	A	Specification of the control, monitoring and safety systems for the LPG fuel installation
19	A	Material, thickness and joints of the LPG fuel pipes
20	A	Diagram of the inert gas piping system
21	A	Diagram of the ventilation systems serving spaces containing LPG piping
22	A	Ventilation duct arrangement in gas-dangerous spaces and adjacent zones
23	A	Diagram of the LPG detection system
24	A	Diagram of LPG heating and vaporizing systems
25	A	Details of LPG fuel pumps and compressors
26	A	Details of process pressure vessels and relative valves and fittings arrangement
27	A	Bilge system of the spaces related to LPG fuel storage and preparation
28	A	Emergency shutdown system
29	A	LPG fuel tank instrumentation (pressure, temperature, level)
30	A	Details of fire-extinguishing appliances and systems related to LPG fuel installation: Water spray system when required to be fitted, Dry chemical powder, Fire Main
31	I	Specification and approval reference of the gas utilization units (engines, gas turbines, boilers)
32	A	Diagram of the gas fuel supply systems, for each gas utilization unit
33	A	Arrangement of the LPG gas valves units
34	A	Diagram of the fuel oil system including pilot fuel supply
35	A	Diagram of the engine lubricating oil system
36	A	Diagram of the engine cooling system
37	A	Diagram of the engine crankcase venting systems
38	A	Drawings of the boilers, including burners
39	A	Drawing of the exhaust gas ducts
40	A	Specification of the control, monitoring and safety systems for each LPG utilization unit
41	A	Instrumentation list
42	A	Safety certificates for electrical equipment located in gas-dangerous spaces or zones, where applicable
43	A	Schematic electrical wiring diagram in areas containing LPG piping and utilization units
44	A	Arrangement of electrical installation in hazardous areas, including lighting system
45	I	Fuel containment system gas freeing procedure, including emptying, inerting and purging
46	I	Procedure for maintenance of the gas utilization units and other gas-related equipment, including the steps to be taken prior to servicing the units
<p>(1) A = to be submitted for approval I = to be submitted for information.</p>		



## 2.3 Classification

**2.3.1** It is reminded that the compliance of LPG-fuelled ships with the functional requirements of the IGF Code should be demonstrated through alternative design. See IGF Code, Part A, Article [2.3] and NR529, Part A, [2.3].

Note 1: Rule Note NR529 "Gas-fuelled ships".

**2.3.2** LPG-fuelled ships that are designed and built in accordance with the relevant Bureau Veritas Rules may be assigned the additional service feature **gasfuel (LPG)** or **dualfuel (LPG)**, as defined in NR467 Rules for Steel Ships, Pt A, Ch 1, Sec 2, [4.13.1].

## 2.4 Definitions

### 2.4.1 LPG

LPG means liquefied petroleum gas, either in the liquid state or in the gaseous state.

### 2.4.2 LPG preparation room

LPG preparation room means any space containing pumps, compressors, heat exchangers and vaporizers for LPG preparation purposes.

### 2.4.3 Design vapour pressure

Design vapour pressure is the maximum gauge pressure, at the top of the tank, to be used in the design of the tank.

### 2.4.4 Low pressure

Low pressure for a LPG piping system means a maximum working pressure lower than or equal to 2,0 MPa.

## 3 General design principles

### 3.1 General functional requirements

**3.1.1** The safety, reliability and dependability of the systems is to be equivalent to that achieved with new and comparable conventional oil-fuelled main and auxiliary machinery.

**3.1.2** The probability and consequences of LPG-related hazards are to be limited to a minimum through arrangement and system design, such as ventilation, detection and safety actions. In the event of gas leakage or failure of the risk reducing measures, necessary safety actions are to be initiated.

**3.1.3** The design philosophy is to ensure that risk reducing measures and safety actions for the LPG installation do not lead to an unacceptable loss of power.

**3.1.4** Hazardous areas are to be restricted, as far as practicable, to minimize the potential risks that might affect the safety of the ship, persons on board, and equipment.

**3.1.5** Hazardous areas shall be restricted, as far as practicable, to minimize the potential risks that might affect the safety of the ship, persons on board, and equipment.

**3.1.6** Unintended accumulation of explosive LPG concentrations is to be prevented.

**3.1.7** LPG system components is to be protected against external damages.

**3.1.8** Sources of ignition in hazardous areas are to be eliminated to reduce the probability of explosions.

**3.1.9** Safe and suitable LPG fuel supply, storage and bunkering arrangements are to be provided, capable of receiving and containing the fuel in the required state without leakage. Other than when necessary for safety reasons, the system is to be designed to prevent venting under all normal operating conditions including idle periods.

**3.1.10** Piping systems, containment and over-pressure relief arrangements that are of suitable design, construction and installation for their intended application are to be provided.

**3.1.11** Machinery, systems and components are to be designed, constructed, installed, operated, maintained and protected to ensure safe and reliable operation.

**3.1.12** Fuel containment system and machinery spaces containing source that might release gas into the space are to be arranged and located such that a fire or explosion in either will not lead to an unacceptable loss of power or render equipment in other compartments inoperable.

**3.1.13** Suitable control, alarm, monitoring and shutdown systems are to be provided to ensure safe and reliable operation.

**3.1.14** Fixed gas detection suitable for all spaces and areas concerned is to be arranged.

**3.1.15** Fire detection, protection and extinction measures appropriate to the hazards concerned are to be provided.

**3.1.16** The technical documentation is to permit an assessment of the compliance of the system and its components with the applicable rules, guidelines, design standards used and the principles related to safety, availability, maintainability and reliability.

**3.1.17** A single failure in a technical system or component is not to lead to an unsafe or unreliable situation.

**3.1.18** It is to be ascertained that the LPG consumers (engines, turbines, boilers) are suitable for all expected characteristics of the LPG.

## 3.2 Limitation of explosion consequences

**3.2.1** An explosion in any space containing any potential sources of release and potential ignition sources shall not:

- a) cause damage to or disrupt the proper functioning of equipment/systems located in any space other than that in which the incident occurs
- b) damage the ship in such a way that flooding of water below the main deck or any progressive flooding occur
- c) damage work areas or accommodation in such a way that persons who stay in such areas under normal operating conditions may be injured
- d) disrupt the proper functioning of control stations and switchboard rooms necessary for power distribution
- e) damage life-saving equipment or associated launching arrangements
- f) disrupt the proper functioning of firefighting equipment located outside the explosion-damaged space
- g) affect other areas of the vessel in such a way that chain reactions involving, inter alia, cargo, gas and bunker oil may arise
- h) prevent persons access to life saving appliances or impede escape routes.

Note 1: Double wall fuel pipes are not considered as potential sources of release.

## 3.3 Risk assessment

**3.3.1** A risk assessment is to be conducted to ensure that risks arising from the use of LPG fuel affecting persons on board, the environment, the structural strength or the integrity of the ship are addressed. Consideration is to be given to the hazards associated with physical layout, operation, process and maintenance, following any reasonably foreseeable failure.

**3.3.2** The risks are to be analysed using risk analysis techniques in accordance with [3.3.5] to [3.3.9], and loss of function, component damage, fire, explosion and electric shock are as a minimum to be considered. The analysis is to ensure that risks are eliminated wherever possible. Risks which cannot be eliminated are to be mitigated as necessary. Details of risks, and the means by which they are mitigated, is to be documented to the satisfaction of the Society.

**3.3.3** The risk assessment is to cover the possible LPG fuel leakages and spills and their consequences, in particular with respect to the accumulation of LPG vapors at low points and their spreading over the ship's spaces through openings.

**3.3.4** The risk assessment is also to cover the consequences of possible variations of bunkered LPG characteristics (temperature, composition).

**3.3.5** The risk assessment is to be carried out in accordance with IACS Recommendation N°146 "Risk assessment as required by the IGF code".

Note 1: The following hazards listed in paragraph 3,2 of IACS Recommendation N°146 are not relevant to LPG: cryogenic burns, low temperature embrittlement, rapid phase transition and rollover.

**3.3.6** An HAZID study is to be carried out for each LPG-fuelled ship. It should cover at least the following spaces, zones and systems:

- tank connection space (TCS)
- enclosed and semi-enclosed fuel preparation rooms
- enclosed and semi-enclosed bunkering stations
- spaces containing high pressure gas or liquid fuel piping
- GVU spaces (except GVU enclosures)
- zones where vent lines and safety valve discharge lines are led including vent mast
- tanks.

**3.3.7** The risks identified by the HAZID study may be mitigated by operational procedures (e.g. stopping ship spaces ventilation during bunkering operations to prevent gas from entering those spaces through openings).

**3.3.8** The risk associated with the release of gas in the event of:

- gas venting or pressure relief
- gas or liquid fuel leakage, including on open decks

is to be assessed by means of a gas dispersion analysis.

**3.3.9** An HAZOP study is to be carried out to cover the process hazards identified in [3.3.4].

## 4 Ship design and arrangements

### 4.1 Functional requirements

**4.1.1** The fuel tank(s) are to be located in such a way that the probability for the tank(s) to be damaged following a collision or grounding or during cargo loading operations is reduced to a minimum taking into account the safe operation of the ship and other hazards that may be relevant to the ship.

**4.1.2** Fuel containment systems, fuel piping and other fuel sources of release are to be so located and arranged that released gas is led to a safe location in the open air.

**4.1.3** The access or other openings to spaces containing fuel sources of release are to be so arranged that gas cannot escape to spaces that are not designed for the presence of gas.

**4.1.4** Fuel piping is to be protected against mechanical damage.

**4.1.5** The propulsion and fuel supply system is to be so designed that safety actions after any gas leakage do not lead to an unacceptable loss of power.

**4.1.6** The probability of a gas explosion in a machinery space with LPG fuelled machinery shall be minimized.

## 4.2 Design and arrangement of LPG tanks

**4.2.1** LPG tanks are to be designed in accordance with the relevant requirements of IGF Code and Rule Note NR529.

**4.2.2** The design pressure of LPG tanks is not to be less than the vapor pressure of propane corresponding to a temperature of 65°C, i.e. 23,4 bar.

**4.2.3** The Maximum Allowable Working Pressure (MAWP) of LPG tanks is not to exceed 90% of the Maximum Allowable Relief Valve Setting (MARVS).

**4.2.4** Loading and filling limits of LPG tanks are to be in accordance with the provisions of NR529 Part A-1, Article [6.8].

**4.2.5** Particular consideration is to be paid to a possible vacuum in the LPG tank.

**4.2.6** LPG tanks are to be protected against mechanical damage.

**4.2.7** LPG tanks and or equipment located on open deck are to be located to ensure sufficient natural ventilation, so as to prevent accumulation of escaped gas.

**4.2.8** LPG tanks are to be protected from external damage caused by collision or grounding in accordance with the requirements for protective location of LNG tanks given in IGF Code and Rule Note NR529 Part A-1 [5].

## 4.3 Arrangement of machinery spaces

**4.3.1** A single failure within the fuel system is not to lead to a gas release into the machinery space.

**4.3.2** All fuel piping within machinery space boundaries are to be enclosed in a gastight enclosure.

**4.3.3** Where a gas turbine is fitted in a gastight enclosure designed to collect, detect and vent any LPG leakage, single wall LPG fuel pipes are acceptable.

## 4.4 Location and protection of fuel piping

**4.4.1** LPG pipes are not to be located less than 800 mm from the ship's side.

**4.4.2** LPG piping is not to be led directly through accommodation spaces, service spaces, electrical equipment rooms or control stations as defined in the SOLAS Convention.

**4.4.3** LPG pipes may be accepted in open spaces or on open deck without protective enclosure against leakage provided that there is no risk of LPG accumulation in case of pipe failure.

**4.4.4** LPG pipes led through ro-ro spaces, special category spaces and on open decks are to be protected against mechanical damage.

## 4.5 LPG preparation room

**4.5.1** LPG fuel preparation rooms are to be located on an open deck, unless a specific analysis is submitted demonstrating that, for the worst leakage scenario, they can withstand the maximum pressure build up in the space, taking into account the pressure relief devices, where fitted.

**4.5.2** The pumping, vaporisation and heating capacity is to be sufficient to provide the required pressure and temperature of the LPG supply at the engine and/or gas turbine inlets in all LPG conditions in the storage tank and operating conditions of the LPG consumers, including transient conditions, irrespective of the ambient conditions. Where necessary, a buffer tank is to be provided.

## 4.6 Regulations for bilge systems and drainage arrangements

**4.6.1** Bilge systems installed in areas where LPG fuel can be present are to be segregated from the bilge system of spaces where LPG fuel cannot be present.

Note 1: Areas where fuel can be present include:

- fuel storage hold spaces
- fuel preparation rooms
- GVU spaces
- bunkering station.

**4.6.2** Bilge lines from spaces where LPG fuel can be present are not to be connected to pumps in safe spaces.

**4.6.3** If bilge drainage of spaces where LPG can be present is arranged by gravity drainage, the drainage is to be led directly overboard or to a closed drain tank located outside the machinery spaces. The tank is to be provided with a vent pipe to a safe location on the open deck and with means for gas detection.

## 4.7 Drip trays

**4.7.1** Drip trays are to be fitted in areas where spills are expected, in particular:

- in way of fuel storage tanks located on open decks, to collect potential leakages from tank connections
- at the bunkering station
- in fuel preparation rooms, in way of possible liquid fuel leakage sources including detachable pipe connections, pumps, valves and heat exchangers.

**4.7.2** Drip trays are to be fitted with means for detecting a leakage and activate the safety systems.

**4.7.3** Each tray is to have a sufficient capacity to ensure that the maximum amount of spill according to the risk assessment can be handled. The capacity of the drip tray is to be determined on the basis of the worst expected leakage scenario and agreed by the Society. For each case, the amount of spill is to be calculated based on the time necessary for leakage detection, ESD activation and effective shutdown of the pressure source and shutoff of the isolating valve.

## 4.8 Regulations for access to hazardous areas

**4.8.1** Direct access is not to be permitted from a non-hazardous space to a hazardous space. Where such openings are necessary for operational reasons, an air lock is to be provided.

**4.8.2** For inerted spaces, access arrangements are to be such that unintended entry by personnel is prevented. If access to such spaces is not from open deck, sealing arrangements are to ensure that leakages of inert gas to adjacent spaces are prevented.

## 4.9 Venting arrangements

**4.9.1** A vent mast is to be fitted for the release of the LPG vapours from:

- discharge from tank pressure relief valves
- discharge lines from other safety valves on the LPG piping system
- venting from gas valve units
- ventilation of the LPG piping enclosure (double wall space).

**4.9.2** The arrangement of the vent mast is to be based on the gas dispersion analysis required in [3.3.8]. It should preclude the risk of accumulation of gas on open decks and of escape of gas into the ship spaces through openings. The provisions of NR529 Part A-1 [5.7.2.7], are to be complied with.

## 5 Fuel containment system

### 5.1 General

**5.1.1** The provisions of NR529, Part A-1, Article [6], for LNG containment systems also apply to LPG.

### 5.2 Operating conditions of the storage tank

**5.2.1** The operating conditions of the tank are to be detailed:

- expected pressure and temperature range of LPG in the tank
- operating principle (vapour bleeding and liquid extraction) and relevant control principles.

### 5.3 Tank pressure relief systems

**5.3.1** The tank pressure relief system is to be in compliance with the provisions of NR529 Part A-1, [6.7.2] and [6.7.3].

## 6 Material and general pipe design

### 6.1 General

**6.1.1** The provisions of NR529, Pt A-1, [7], for material and design of LNG piping systems also apply to LPG, taking into account modifications detailed in [6.2] and [6.3].

## 6.2 Functional requirements

**6.2.1** LPG systems are to be designed to prevent phase changes in the supply system up to the consumers.

**6.2.2** Arrangements are to be made to deal with icing of LPG piping components due to low temperatures in the LPG storage tank or vaporization of pressurized LPG fuel.

### 6.3 Materials

**6.3.1** LPG supply lines are to be made of drawn copper or drawn stainless steel. Steel and aluminium are not permitted.

### 6.4 Prevention of phase changes in LPG supply lines

**6.4.1** Where LPG fuel is intended to be used in the gaseous state and has a dew point higher than ambient temperature at the maximum expected pressure at the consumer inlet, the fuel is to be sufficiently heated and the fuel lines are to be properly heat traced.

**6.4.2** Where LPG fuel is intended to be used in the liquid state, the pressure in the fuel manifold is to be sufficient to maintain the fuel in the liquid state.

## 7 Bunkering

### 7.1 General

**7.1.1** The provisions of NR529, Part A-1, Article [8], for LNG bunkering also apply to LPG, taking into account modification detailed in [7.2].

### 7.2 Arrangement of the bunkering station

**7.2.1** The bunkering station is to be arranged without low points or obstacles that could lead to LPG vapour accumulation.

## 8 Fuel supply to consumers

### 8.1 General

**8.1.1** The provisions of NR529 Part A-1, Article [9] for LNG fuel supply to consumers also apply to LPG, taking into account modification in [8.2].

### 8.2 Secondary enclosure for LPG fuel piping

**8.2.1** Where required by [4.3] and [4.4], the secondary enclosure against leakage is to fulfil one of the following conditions:

- a) ventilated arrangement:
  - the enclosure consists of a pipe or duct maintained at a pressure lower than the atmospheric pressure by an extraction ventilation system having a capacity of at least 30 air changes per hour
  - the air inlet is to be from the open deck and is to be connected to the upper part of the enclosure

- the extraction fan is to be connected to the lowest point of the enclosure and is to discharge to a position on the open deck
- a LPG detector is to be provided at the fan discharge.

b) inert gas-pressurized arrangement:

- the enclosure consists of a pipe or duct pressurized with inert gas at a pressure greater than the LPG fuel pressure
- a pressure monitoring is to be provided for the space between the LPG fuel pipe and the enclosure.

## 9 Power generation including propulsion and other LPG consumers

### 9.1 General

**9.1.1** The provisions of NR529, Part A-1, Article [10], for LNG consumers also apply to LPG, taking into account modification detailed in [9.2].

### 9.2 Diesel engines

**9.2.1** LPG engines are to be type approved on the basis of the risk assessment (see [9.2.3]) and type testing (see [9.2.4]).

**9.2.2** LPG engines to be designed to operate satisfactorily with all expected compositions of the LPG fuel.

**9.2.3** The risk assessment of the engine is to be carried out using an HAZID analysis or other acceptable methods. It should cover in particular the following hazards:

- presence and possible accumulation of gaseous LPG in the charge air system and in the crankcase (Otto cycle engines)
- condensation of LPG vapours in the gas supply system (Otto cycle engines)
- leakage of high pressure liquid LPG (Diesel cycle engines)
- presence of unburnt LPG vapours in the exhaust system
- failure of a LPG admission valve or injection valve
- failure of the ignition system (spark plug or pilot injection).

The possible variations of the LPG characteristics associated with its composition (density, flashpoint, heat value, flammability range) are to be considered.

**9.2.4** The engine is to undergo at least the following type tests, in addition to those required in NR467 Rules for Steel Ships, Part C, Chapter 1, Section 2, for standard Diesel engines:

- for dual fuel engines, the lowest specified speed is to be verified in diesel mode and gas mode
- for dual-fuel engines, switch over between gas and diesel modes are to be tested at different loads
- the efficiency of the ventilation arrangement of the double walled gas piping system is to be verified
- the capability of engines driving generators to accept sudden load variations is to be verified. See NR467 Rules for Steel Ships, Pt C, Ch 1, Sec 2, [2.7.5].

### 9.3 Gas Turbine

**9.3.1** Gas turbines are to be type approved in accordance with the requirements of the NR467 Rules for Steel Ships, Pt C, Ch 1, Sec 5.

**9.3.2** Gas turbines are to be tested according to a program approved by the Society. This program is to include the following tests:

- capability of the turbine to operate with the different expected LPG fuel compositions
- capability of the turbine to switch over from LPG fuel to oil fuel
- operation at low load
- load variation test.

## 10 Fire safety and explosion prevention

### 10.1 General

**10.1.1** The provisions of NR529 Part A-1, Articles [11] and [12], also apply to LPG.

### 11 Ventilation

#### 11.1 General

**11.1.1** The provisions of NR529 Part A-1, Article [13], for ventilation also apply to LPG, taking into account modification detailed in [11.2].

#### 11.2 Arrangement of the ventilation systems serving hazardous spaces

**11.2.1** Ventilation systems serving hazardous spaces are to be designed to avoid accumulation of LPG vapours at the bottom of the space in case of leakage. The ventilation capacity is to be at least 30 air changes per hour.

**11.2.2** The ventilation outlets are to be located at the lowest part of the space and suitably protected.

**11.2.3** Bunkering stations that are not located on open deck are to be suitably ventilated to ensure that any vapour being released during bunkering operations will not accumulate inside the bunkering station. If the natural ventilation is not sufficient for this purpose, mechanical extraction ventilation is to be provided.

## 12 Electrical installations

### 12.1 General

**12.1.1** The provisions of NR529 Part A-1, Article [14], for electrical installations also apply to LPG, taking into account modification detailed in [12.2].

### 12.2 Electrical equipment for hazardous areas

**12.2.1** Electrical equipment for hazardous areas is to be certified for all expected compositions of LPG to be used.

## 13 Control, monitoring and safety systems

### 13.1 General

**13.1.1** The provisions of NR529 Part A-1, Article [15], for control, monitoring and safety systems also apply to LPG, taking into account modification detailed in [13.2].

### 13.2 Regulation for gas detection

**13.2.1** Permanently installed gas detectors are to be fitted:

- a) in the tank connection spaces
- b) in all ducts around fuel pipes
- c) in machinery spaces containing LPG piping, equipment or consumers
- d) in enclosed or semi-enclosed compressor rooms and fuel preparation rooms

- e) in other enclosed spaces containing LPG piping or equipment without ducting (e.g. gas valve units spaces or enclosures)
- f) in other enclosed or semi-enclosed spaces where LPG vapours may accumulate (including hold spaces of independent tanks other than type C)
- g) in air locks
- h) in gas heating circuit expansion tanks
- i) in motor rooms associated with the LPG systems
- j) at ventilation inlets to accommodation and machinery spaces
- k) at ventilation inlets to special category spaces
- l) in enclosed and semi-enclosed bunkering stations.

**13.2.2** The detection equipment is to be located:

- at the bottom of the concerned space, in locations where LPG is likely to accumulate
- in the ventilation outlet.

**13.2.3** The number of detectors in each space is to be considered taking into account the size and layout of the space, in particular when its bottom is not flat or shows discontinuities.

**13.2.4** Gas dispersion analysis or smoke tests are to be carried out to justify the detector arrangement (number and location) in the following spaces:

- enclosed or semi-enclosed compressor rooms and fuel preparation rooms
- tank connection spaces
- enclosed and semi-enclosed bunkering stations.

## 14 Manufacture, workmanship and testing

### 14.1 General

**14.1.1** The provisions of NR529 Part A-1, Article [16], for manufacture, workmanship and testing also apply to LPG.