

GUIDE FOR BUILDING AND CLASSING

GRAVITY-BASED OFFSHORE LNG TERMINALS JUNE 2010

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GUIDE FOR BUILDING AND CLASSING

GRAVITY-BASED OFFSHORE LNG TERMINALS

JUNE 2010 (Updated February 2016 – see next page)

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16855 Northchase Drive
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Foreword

This *Guide for Building and Classing Gravity-Based Offshore LNG Terminals (GBLNGT Guide)* replaces previous editions of the *Guide for Building and Classing Offshore LNG Terminals*. The *GBLNGT Guide* also describes criteria to be used for gravity based offshore LNG terminals which are to be classed or certified by American Bureau of Shipping (ABS).

ABS is willing to expand the criteria for handling other gaseous materials for gravity based terminals as the industry demand for same increases. ABS recognizes that industry participation is a vital factor due to the rapidly progressing use of offshore gas terminals. To understand and apply this new technology and its standards, ABS, the offshore and onshore community, and regulatory agencies would benefit from having a common understanding of the terms and concepts involved, and an awareness of how these concepts are to be applied to ABS rule-making. This continues to be the driving force for the Guide.

The effective date of this Guide is 1 June 2010. In general, until the effective date, plan approval for designs will follow prior practice unless review under this Guide is specifically requested by the party signatory to the application for classification.

Changes to Conditions of Classification

Chapter 1, Section 1, “Scope and Conditions of Classification” was consolidated into a generic booklet, entitled *Rules for Conditions of Classification – Offshore Units and Structures (Part 1)* for all units, installations, vessels or systems in offshore service. The purpose of this consolidation was to emphasize the common applicability of the classification requirements in “Chapter 1, Section 1” to ABS-classed offshore units, pipelines, risers, and other offshore structures, and thereby make “Conditions of Classification” more readily a common Rule of the various ABS Rules and Guides, as appropriate.

Thus, Chapter 1, Section 1 of this Guide specifies only the unique requirements applicable to gravity-based offshore liquefied gas terminals. These supplemental requirements are always to be used with the aforementioned *Rules for Conditions of Classification – Offshore Units and Structures (Part 1)*.

Reference Note

Reference to a paragraph in the *Steel Vessel Rules*, *MODU Rules* or *FPI Rules* is made in the format ‘P-C-S/ss.p’ where ‘P’ is the Part, ‘C’ is the Chapter, ‘S’ is the Section, ‘ss’ is the Subsection and ‘p’ is the Paragraph.

Reference to a paragraph in this Guide is made in the format ‘C-S/ss.p’, where ‘C’ is the Chapter, ‘S’ is the Section, ‘ss’ is the Subsection and ‘p’ is the Paragraph.

Reference to a Figure or Table in this Guide is made, respectively, in the format ‘C-S/Figure #’, or ‘C-S/Table #’.



GUIDE FOR BUILDING AND CLASSING

GRAVITY-BASED OFFSHORE LIQUEFIED GAS TERMINALS

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CHAPTER 1 Conditions of Classification

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CHAPTER 1 Conditions of Classification

SECTION 1 Scope and Conditions of Classification (Supplement to the ABS Rules for Conditions of Classification – Offshore Units and Structures)

1 Classification

The requirements for conditions of classification are contained in the separate, generic *ABS Rules for Conditions of Classification – Offshore Units and Structures (Part 1)*.

Additional requirements specific to gravity-based offshore LNG terminals are contained in the following Subsections.

3 Purpose

A *Gravity-Based Offshore LNG Terminal* provides LNG storage and receives and/or offloads LNG. There are two major variations of offshore LNG terminal: Load Terminals and Discharge Terminals, with various configurations of each.

A *Load Terminal* receives gas directly from one or more wells or from another offshore facility where it may or may not have been processed. The gas is liquefied in an onboard liquefaction facility and stored for offloading as LNG to a trading LNG carrier. Alternatively, a *Load Terminal* may receive LNG from a liquefaction plant via a pipeline.

A *Discharge Terminal* receives LNG from trading LNG carriers and stores it. In such terminals, the stored LNG is normally vaporized in a re-gasification facility and discharged ashore. However, offloading LNG in a lightering operation is also feasible.

5 Classification Symbols and Notations

A listing of Classification Symbols and Notations available to the Owners of vessels, offshore drilling and production units and other marine structures and systems, “List of ABS Notations and Symbols” is available from the ABS website “<http://www.eagle.org>”.

The following notations are specific to gravity-based offshore LNG terminals.

5.1 Class Notations

Gravity-based offshore LNG terminals that have been built, installed and commissioned to the satisfaction of the ABS Surveyors to the full requirements of this Guide, where approved by the Committee for service for the specified design environmental conditions, may be classed and distinguished in the *ABS Record* by the symbol **A1**, followed by **Offshore Liquefied Gas Terminal** and the appropriate notation for the intended service listed below.

Class notations were chosen to provide a clear description of the function of each configuration using the following symbols:

G	Gravity Based
L	Liquefaction Facility
O	Transfer of LNG (Offloading/Loading)
P	Gas Processing Facility
R	Re-Gasification Facility
S	Storage Facility
T	Terminal with processing facilities that are not classed

A complete description of applicable class notations is provided for gravity-based offshore LNG terminals in 2-1/1.1 of this Guide.

5.3 Geographical Limitations

Gravity-based offshore LNG terminals which have been built to the satisfaction of the ABS Surveyors to special modified requirements for a limited service, where approved by the Committee for that particular service, may be classed and distinguished in the *Record* by suitable symbols or notations, but the symbols or notations will either be followed by or have included in them the appropriate service limitation.

5.5 Terminals Not Built Under Survey

The symbol “✕” (Maltese-Cross) signifies that the system was built, installed and commissioned to the satisfaction of the ABS Surveyors. Gravity-based offshore LNG terminals and their equipment that have not been built under ABS survey, but which are submitted for Classification, will be subjected to special consideration. Where found satisfactory and thereafter approved by the Committee, they may be classed and distinguished in the *Record* by the notation described above, but the symbol “✕” signifying survey during construction will be omitted.

7 Rules for Classification

7.1 Application of Rules

This Guide contains provisions for the classification of gravity-based offshore LNG terminals. This Guide is intended for use in conjunction with the *ABS Rules for Building and Classing Steel Vessels (Steel Vessel Rules)*, *ABS Rules for Building and Classing Mobile Offshore Drilling Units (MODU Rules)*, *ABS Rules for Building and Classing Offshore Installations*, *ABS Rules for Building and Classing Floating Production Installations (FPI Rules)* or other applicable ABS Rules and Guides.

7.3 Scope of Class

A description of the parts of a gravity-based offshore LNG terminal included in the ABS classification is provided in 2-1/1 of this Guide.

7.5 Alternatives

Any departure from the requirements of this Guide may be considered by ABS on the basis of an additional risk assessment to that required per 2-2/3 of this Guide, or at least a separate, clearly identified part of the risk assessment. In the case of such departures, classification is subject to ABS's approval upon a demonstration of fitness for purpose in line with the principles of ABS Guides and Rules, as well as recognized and generally accepted good engineering practice. Risk acceptance criteria are to be developed in line with the principles of the ABS Rules and are subject to ABS's approval. The *ABS Guidance Notes on Risk Assessment Application for the Marine and Offshore Oil and Gas Industries* contain an overview of risk assessment techniques and additional information.

A risk approach justification of alternatives may be applicable either to the terminal as a whole or to individual systems, subsystems or components. As appropriate, account must be given to remote hazards outside of the bounds of the system under consideration. Such account must include incidents relating to remote hazards directly affecting or being influenced by the system under consideration. ABS will consider the application of risk-based techniques in the design of the terminal, verification surveys during construction and surveys for maintenance of class.

Portions of the terminal not included in the risk assessment are to comply with the applicable parts of the ABS Rules.

The following are the responsibility of the Owner/Operator:

- i) Risk acceptance criteria
- ii) Hazard identification
- iii) Risk assessment
- iv) Risk management
- v) Compliance of the system under consideration with the applicable requirements of Flag and Coastal State

9 Units

This Guide is written in three systems of units, viz., SI units, MKS units and US customary units. Each system is to be used independently of any other system.

Unless indicated otherwise, the format of presentation in this Guide of the three systems of units, is as follows:

SI units (MKS units, US customary units)

11 Abbreviations and References

11.1 Abbreviations

ABS	American Bureau of Shipping
ACI	American Concrete Institute
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
API	American Petroleum Institute
ASTM	American Society for Testing and Materials
ASME	American Society of Mechanical Engineers
AWS	American Welding Society
CSA	Canadian Standards Association
FIP	Federation Internationale de la Precontrainte
IMO	International Maritime Organization
NACE	National Association of Corrosion Engineers
NFPA	National Fire Protection Association
PCI	Prestressed Concrete Institute
SIGTTO	Society of International Gas Tanker and Terminal Operators Ltd.

11.3 References

- i) *Steel Vessel Rules – ABS Rules for Building and Classing Steel Vessels*
- ii) *MODU Rules – ABS Rules for Building and Classing Mobile Offshore Drilling Units*
- iii) *M/W Rules – ABS Rules for Materials and Welding – Part 2*
- iv) *Offshore Installations Rules – ABS Rules for Building and Classing Offshore Installations*
- v) *SPM Rules – ABS Rules for Building and classing Single Point Moorings*
- vi) *FPI Rules – ABS Rules for Building and Classing Floating Production Installations*
- vii) *Facilities Rules – ABS Rules for Building and Classing Facilities on Offshore Installations*
- viii) *LGC Guide – ABS Guide for Building and Classing Liquefied Gas Carriers with Independent Tanks*
- ix) *ABS Guide for Automatic or Remote Control and Monitoring for Machinery and Systems (other than Propulsion) on Offshore Installations*
- x) *ABS Guide for the Fatigue Assessment of Offshore Structures*
- xi) *ABS Guide for Nondestructive Inspection of Hull Welds*
- xii) *ABS Guidance Notes on Risk Assessment Application for the Marine and Offshore Oil and Gas Industries*
- xiii) *ABS Guide for Risk Evaluations for the Classification of Marine-Related Facilities*
- xiv) *ABS Guidance Notes on Review and Approval of Novel Concepts*
- xv) *ABS Guide for Surveys Using Risk Based Inspection for the Offshore Industry*
- xvi) *ABS Guide for Surveys Based on Reliability-Centered Maintenance*
- xvii) *ACI 213R Guide for Structural Lightweight Aggregate Concrete*
- xviii) *ACI 301 Specifications for Structural Concrete*
- xix) *ACI 311.4R Guide for Concrete Inspection Programs*
- xx) *ACI 318 Building Code Requirements for Structural Concrete*
- xxi) *ACI 357R-84 Guide for the Design and Construction of Fixed Offshore Concrete Structures*
- xxii) *ACI 357.2R-88 State-of-the-Art Report on Barge-Like Concrete Structures*
- xxiii) *AISC Manual of Steel Construction, ASD*
- xxiv) *API RP 2A, RP 2T, RP 14C, RP 500, RP 521, 620, RP 2003*
- xxv) *ASTM 330 Specification for Lightweight Aggregates for Structural Concrete*
- xxvi) *CSA S474-94 Concrete Structures (Offshore Structures)*
- xxvii) *NACE RP0176-94*
- xxviii) *NFPA 59 A Standard for Production, Storage and Handling of Liquefied Natural Gas*

Note: The requirements of the IMO “International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk” are incorporated within requirements in Part 5C, Chapter 8 of the ABS *Steel Vessel Rules*.

ABS is prepared to consider other appropriate alternative methods and recognized codes of practice.

CHAPTER 2 Requirements for Gravity-Based Offshore LNG Terminals

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CHAPTER 2 Requirements for Gravity-Based Offshore LNG Terminals

SECTION 1 Classification of Gravity-Based Offshore LNG Terminals

In addition to all of the requirements contained in the ABS Rules for Conditions of Classification – Offshore Units and Structures (Part 1) and Chapter 1 of this Guide, the following requirements are applicable to gravity-based offshore LNG terminals.

1 ABS Class Symbols and Notations

1.1 Class Notations

Gravity-based LNG terminals (GBLNGT) that have been built, installed and commissioned to the satisfaction of the ABS Surveyors to the full requirements of this Guide, where approved by the Committee for service for the specified design environmental conditions, may be classed and distinguished in the *ABS Record* by the symbol **✕ A1**, followed by **Offshore Liquefied Gas Terminal** and the appropriate notation for the intended service listed below:

Class notations were chosen to provide a clear description of the function of each configuration using the following symbols:

- G** Gravity-Based
- L** Liquefaction Facility
- O** Transfer of LNG (Offloading/Loading)
- P** Gas Processing Facility
- R** Re-Gasification Facility
- S** Storage Facility

Where a gravity-based terminal is fitted with processing facilities, but classification of the entire processing facilities is not desired, certain essential safety systems and equipment for the processing facilities as indicated in 2-2/9 of this Guide are to be in compliance with requirements of ABS. The gravity-based terminal will be classed and distinguished in the *ABS Record* by the symbol **✕ A1** followed by **Offshore Liquefied Gas Terminal** and the notation **T**.

The class notations are:

G(LNG) PLSO – Gravity-Based LNG Terminals with Gas Processing and Production, Liquefaction, Storage and Offloading – The terminal receives well gas, processes it and liquefies the natural gas and condensate for storage and offloading.

G(LNG) ORS – Gravity-Based LNG Storage Terminals with Re-Gasification Facility – The terminal receives LNG from a trading LNG carrier, stores it, re-gasifies and discharges the gas ashore.

G(LNG) SO – Gravity-Based LNG Storage and Offloading Terminals – The terminal receives, stores and offloads LNG in a lightering operation

G(LNG) T – Gravity-Based LNG Terminals with Gas Processing and Production, Liquefaction, Storage and Offloading – The terminal receives well gas, processes it, liquefies the natural gas and condensate for storage and offloading. The gas processing, production and liquefaction facilities are not desired to be within the scope of class. However the essential safety features of these facilities are to comply with ABS requirements.

1.3 ✕ AMCC and ✕ AMCCU Notations

Automatic or remote control and monitoring equipment/machinery that have been constructed and installed to the satisfaction of the ABS Surveyors and to the full requirements of the *ABS Guide for Automatic or Remote Control and Monitoring for Machinery and Systems (other than propulsion) on Offshore Installations*, when found satisfactory after trial and approved by the Committee, may be classed and distinguished in the *Record* by the notation ✕ **AMCC**. Where it is intended that the machinery be controlled and monitored from a remote control and monitoring center located outside the machinery space(s), a Class notation ✕ **AMCCU** will be assigned. It should be noted that the above notations do not cover the instrumentation and control systems for any process systems.

1.5 Application of Class Notations

The class notations described above cover the following components:

- i) Gravity-based offshore LNG terminals including the terminal's principal structure, equipment, machinery and all electrical systems under one of the notations in 2-1/1.1 above, subject to the requirements of this Guide.
- ii) Foundations in accordance with the requirements of this Guide.
- iii) Gas processing, production and liquefaction facilities according to the requirements of this Guide and the applicable sections of the *Facilities Rules*.
- iv) LNG storage facilities (Containment Systems) in accordance with the requirements of this Guide and the applicable sections of Part 5C of the *Steel Vessel Rules*.
- v) Inlet and outlet facilities in accordance with the requirements of this Guide.
- vi) LNG and GNG (Gaseous Natural Gas/LNG vapor) handling systems in accordance with the requirements of this Guide and the applicable sections of Part 5C of the *Steel Vessel Rules*.
- vii) Re-gasification facilities in accordance with the requirements of this Guide.
- viii) Safety systems in accordance with the requirements of this Guide.
- ix) Helicopter landing area in accordance with the requirements of this Guide and the applicable sections of the *Steel Vessel Rules*.

TABLE 1
Terminal Configuration

	Structure	Storage	Gas Processing	Liquefaction	Gasification	Station Keeping Foundation	Import and Export Systems	Risers and Flow Lines	Min. System Compliance Required
G(LNG)PLSO	X	X	X	X	—	X	X	Optional	X
G(LNG)LSO	X	X	—	X	X	X	X	Optional	X
G(LNG)ORS	X	X	—	—	X	X	X	Optional	X
G(LNG)SO	X	X	—	—	—	X	X	Optional	X
G(LNG)T	X	X	—	—	—	X	X	—	X

Notes:

- P** = Process
L = Liquefaction
S = Storage
O = Transfer of LNG (Offloading/Loading)
R = Re-gasification
T = Terminal with processing facilities which are not classed

3 Plans and Data to be Submitted

(2011) Plans and data to be submitted for design review shall generally be submitted electronically to ABS. However, hard copies will also be accepted. Proceeding paragraphs of this Subsection “Plans and Data to be Submitted” cover submittals for the full variety of Class Notations. The actual extent of plans and data to be submitted depend upon the equipment, machinery and systems installed on the terminal and requested for Classification by the Owner.

3.1 Design Plans and Data for Structures

Plans showing the scantlings, arrangements and details of the principal parts of the hull structure of each terminal to be built under survey are to be submitted and approved before the work of construction has commenced. These plans are to clearly indicate the scantlings, joint details and welding, or other methods of connection. In general, plans are to be submitted that include the following, where applicable:

- Arrangement plans, elevations and plan views clearly showing in sufficient detail the overall configuration, dimensions and layout of the structure, its facilities and foundation
- Layout plans indicating the locations of equipment and locations of the equipment loads and other design deck loads, fender loads, etc., which are imposed on the structure
- Structural plans indicating the complete structural arrangement, dimensions, member sizes, plating and framing, material properties and details of connections and attachments; for concrete structures, plans indicating general notes about materials and workmanship, arrangements and details of reinforcement, typical details of concrete cover, the location and detail of construction joints, waterstops, etc.
- Pile plans indicating arrangements, nominal sizes, thicknesses and penetration
- Welding details and procedures, and schedule of nondestructive testing
- Corrosion control systems
- Structural plans indicating the complete arrangements of structures, such as helidecks, crane pedestals, equipment foundations and manner of reinforcement, fendering, various houses and other structures which are not normally considered vital to the overall structural integrity of the offshore structure
- Various information in support of novel features utilized in the offshore structure design such as hydrostatic and stability curves, elements of any mooring system, etc.

3.1.1 Site Condition Reports

The site condition reports are to be submitted. For details, refer to 1/1.11.1 of the *Offshore Installation Rules*. The principal purpose of these reports is to demonstrate that site conditions have been evaluated in establishing design criteria. Among the items to be discussed are:

- i) Environmental conditions of waves, winds, currents, tides, water depth, air and sea temperature and ice
- ii) Seabed topography, stability and pertinent geotechnical data
- iii) Seismic conditions

Where appropriate, data established for a previous installation in the vicinity of the installation proposed for classification may be utilized if acceptable in the opinion of ABS.

3.1.2 Design Data and Calculations

Information is to be submitted for the terminal that describes the methods of design and analysis which were employed to establish its design. The estimated design service life of a terminal is also to be stated. Where model testing is used as a basis for a design, the applicability of the test results will depend on the demonstration of the adequacy of the methods employed, including enumeration of possible sources of error, limits of applicability and methods of extrapolation to full-scale data. Preferably, procedures should be reviewed and agreed upon before model testing is done.

As required in subsequent Sections, calculations are to be submitted to demonstrate the sufficiency of the proposed design. Such calculations are to be presented in a logical and well-referenced fashion employing a consistent system of units. Where the calculations are in the form of computer analysis, the submittal is to provide input and output data with computer-generated plots for the structural model. A program description (not listings), user manuals and the results of program verification sample problems may be required to be submitted.

3.1.3 Plans or Specifications

Plans or specifications depicting or describing the arrangements and details of the major items of the terminal are to be submitted for review or approval in a timely manner.

Documentation to facilitate the survey of concrete quality, as applicable to the Quality Control Plan (QCP) (see 2-3/3.5 for details), is to be submitted for approval.

Detailed procedural descriptions and design calculations covering all phases of the construction, transportation and installation of the gravity-based structure are to be submitted prior to the work being done.

Where deemed appropriate, and when requested by the Owner, a schedule for information submittal and plan approval can be jointly established by the Owner and ABS. This schedule, which ABS will adhere to as far as reasonably possible, is to reflect the construction schedule and the complexity of the terminal as it affects the time required for review of the submitted data.

3.1.4 Information Memorandum

An information memorandum on the terminal is to be prepared and submitted to ABS. ABS will review the contents of the memorandum to establish consistency with other data submitted for the purpose of obtaining classification. ABS will not review the contents of the memorandum for their accuracy or the features described in the memorandum for their adequacy.

An information memorandum is to contain, as appropriate to the terminal, the following:

- Site plan indicating the general features at the site and the exact location of the terminal
- Environmental design criteria, including the recurrence interval used to assess environmental phenomena (2-2/1.1)
- Plans showing the general arrangement of the terminal
- Description of the safety and protective systems provided
- The number of personnel to be normally stationed at the terminal
- Listing of governmental authorities having cognizance over the terminal
- Listing of any novel features
- Brief description of any monitoring proposed for use on the terminal
- Description of transportation and installation procedures

3.3 Design Plans for LNG Containment System, LNG and GNG Handling Systems

The following plans, calculations and information, as appropriate, are to be submitted in addition to those required by Section 1-1-7 of the *ABS Rules for Conditions of Classification – Offshore Units and Structures (Part 1)*:

- Full particulars of the intended cargo including maximum vapor pressure, minimum and maximum temperature, and loading and storage procedures
- General arrangement plans of the terminal showing the position of the following:
 - i) Cargo containment system, cargo tanks, fuel oil, water ballast and other tanks and void spaces
 - ii) Manholes and any other opening of the cargo tanks
 - iii) Doors and other openings in cargo pump and compressor rooms and other gas-dangerous rooms

- iv) Ventilation ducts of cargo compressor rooms and other “gas-dangerous” spaces
 - v) Door, air-locks, manholes, ducts and other openings for “non-gas-dangerous” spaces which are, however, adjacent to the cargo area
 - vi) Cargo piping, both liquid and gaseous phases, located under and above deck
 - vii) Vent piping and gas-freeing piping and protective devices such as flame screens, etc. fitted at the outlet end of the vents etc.
 - viii) Gas-dangerous spaces
- Plans of the terminal structure in way of the cargo tanks, including the installation of attachments, accessories, internal reinforcements, saddles for support and tie-down devices
 - Plans of the structure of the cargo containment system, including the installation of attachments, supports and attachment of accessories. 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.
 - Distribution of the grades and of the types of steel proposed for use in the structures of the terminal together with the calculation of the temperatures on all of the structures which can be affected by the low temperatures of the cargo
 - Results of direct calculations of the stresses in the cargo containment system
 - Specifications and plans of the insulation system and calculation of the heat balance
 - Thermal heat analysis determining the LNG boil-off rate from the storage tanks
 - Calculations to show the means provided for handling the boil-off gas from storage tanks without causing overpressurization in the tanks
 - Procedures and calculations of the cooling down, loading and unloading operations
 - Loading and unloading systems, venting systems and gas-freeing systems, as well as a schematic diagram of the remote controlled valve system
 - Details and installation of the safety valves and relevant calculations of their relieving capacity
 - Details and installation of the various monitoring and control systems, including the devices for measuring the level of the cargoes in the tanks and the temperatures in the containment system
 - Schematic diagram of the ventilation system indicating the vent pipe sizes and height of the openings above the main deck
 - Schematic diagram of the refrigeration system together with the calculations concerning the refrigerating capacity for a re-liquefaction plant, if provided
 - Details of the electrical equipment installed in the cargo area and of the electrical bonding of the cargo tanks and piping
 - Where fitted, plans and specifications relative to the use of the cargo as fuel for boilers and internal combustion engines (general installations; schematic diagram of the fuel-gas lines with the indication of all of the valves and safety devices; compressors of the fuel gas and relevant engines; fuel-gas heaters and pressure vessels; installation of the burners of the fuel-gas and of the fuel oil; electrical bonding systems)
 - Details of testing procedures of cargo tanks and liquid and vapor systems
 - Diagram of inert-gas system or hold-space environmental-control system
 - Diagram of gas-detection system
 - Jettison arrangements, if provided
 - Details of all cargo and vapor handling equipment

- Welding procedure for LNG storage tanks and LNG and GNG piping systems
- Emergency shutdown arrangements
- Construction details of cargo and booster pumps and compressors including material specification
- Hazardous areas drawing showing access, openings, vent outlets
- De-watering and ballast arrangement for the cargo area

3.5 Design Plans for Process Facilities, Support and Safety Systems

3.5.1 Process and Re-Gasification Facilities

- The process system description
- Project specification and overall process concept evaluation
- Process flow sheets
- Heat and mass balance
- Equipment layout drawings
- Area classification and ventilation drawings
- Piping and Instrument Diagrams (P&IDs)
- Safety Analysis Function Evaluation (SAFE) charts
- Shut down and emergency shut down system (to include a hazard analysis and Failure Modes and Effects Analysis (FMEA) to identify critical components)
- Pressure relief and depressurization systems
- Flare and vent systems
- Spill containment, closed and open drain systems
- Process equipment documentation including calculations showing suitability of all pressurized components in the system to withstand the maximum design pressure that a specific component is likely to encounter in service
- Process piping systems
- Packaged process units
- The monitoring and control system for the entire system pressure regulation and gas dispersion system (to include calculations for sizing of the venting system and the relief valve) radiant heat analysis to demonstrate that the radiant heat intensity at any deck level or location where normal maintenance or operating activity could take place is not exceeding API RP 521 recommendations.

3.5.2 Process Support and Service Systems

- Piping and Instrument Diagrams (P&IDs) for each system
- Equipment documentation
- Process support piping specifications
- Specifications and data sheets for internal combustion engines and turbines
- Specifications and data sheets for cranes (Optional)
- Marine support systems as required by the ABS Rules applicable to the type of terminal

3.7 Electrical Installations

- Electrical one-line diagrams
- Short-circuit current calculations
- Coordination study
- Specifications and data sheets for generators and motors
- Specifications and data sheets for distribution transformers
- Details of storage batteries
- Details of emergency power source
- Standard details of wiring cable and conduit installation practices
- Switchboards and distribution panel
- Panel board
- Installations in classified areas

3.9 Instrumentation and Control Systems

- General arrangements
- Data sheet
- Schematic drawings – Electrical systems
- Schematic drawings – Hydraulic and pneumatic systems
- Programmable electronic systems

3.11 Fire Protection and Personnel Safety

- Firewater system
- Water spray (Deluge) systems for any deckhouse, superstructure and manifold areas
- Water spray (Deluge) systems for process equipment
- Dry powder system for LNG storage tank area
- Fixed fire extinguishing systems
- Paint lockers and flammable material storerooms
- Emergency control stations
- Portable and semi-portable extinguishers
- Fire and gas detection and alarm systems
- Fire and gas cause and effect chart
- Structural fire protection (which indicates classification of all bulkheads and decks for quarters section, machinery spaces and processing facilities)
- Heating Ventilation and Air Conditioning (HVAC) plan [including Air Handling Unit (AHU)] location, duct layout, duct construction and bulkhead and deck penetration details
- Joiner detail arrangement and structural fire protection material certification
- Guard rails
- Escape routes (may be included on the fire control plan or separate plan)
- Lifesaving appliances and equipment plan (escape routes must be indicated)

- Insulation of hot surfaces
- Fire and explosion hazard analysis
- Due to the varying configurations of the project, some portions of these requirements may not be applicable

3.13 Installation Procedures

- Procedures for loading sections of the terminal structure, deck area, process modules decks and topsides
- Procedures for carrying out all installation work offshore including foundation preparation, platform installation and completion

3.15 Start-up and Commissioning Manual

- Provisions/procedures for start-up
- Manual/procedures for commissioning trials

CHAPTER 2 Requirements for Gravity-Based Offshore LNG Terminals

SECTION 2 Design of Gravity-Based Offshore LNG Terminals

1 Environmental Loading and Design Basis

1.1 Environmental and Related Conditions

1.1.1 General

The minimum recurrence interval used to establish the magnitude of the *Design Environmental Condition* is 100 years, except where the use of a shorter recurrence interval produces higher magnitude load effects. As applicable, when a National Authority having jurisdiction over the LNG terminal specifies the use of a lower return period, this will be specially considered.

1.1.2 Environmental Conditions

The gravity-based terminal is to be designed for the site-specific environmental conditions specified in Part 3 of the *Offshore Installations Rules*. In addition to the *Design Environmental Conditions* mentioned above, the designer is to specify any limiting *Operating Environmental Conditions*. These are sets of characteristic parameters for the environmental factors that need to be limited so that the safe performance of an operation or function is not compromised. Such operations may include, as appropriate, transportation and installation of the gravity-based terminal structure itself and for conditions after the gravity-based terminal structure's installation (berthing and mooring of cargo and supply vessels, cargo transfer, personnel transfer, fuel oil transfer etc.). These sets of conditions are herein referred to as *Operating Environmental Conditions*.

1.1.3 Environmental Factors to be Considered

In general, the design of the gravity-based terminal will require investigation of the following environmental factors, as appropriate to the type of terminal structure and the terminal's installation site:

- i) Waves
- ii) Wind
- iii) Currents
- iv) Tides and storm surges
- v) Air and sea temperatures
- vi) Ice and snow
- vii) Marine growth
- viii) Seismicity
- ix) Sea ice

Other phenomena, such as tsunamis, submarine slides, seiche, abnormal composition of air and water, air humidity, salinity, ice drift, icebergs, ice scouring, etc. may require investigation depending upon the specific installation site.

The required investigation of seabed and soil conditions is described in Section 3/6 of the *Offshore Installations Rules*.