OFFSHORE SERVICE SPECIFICATION
DNV-OSS-309

VERIFICATION, CERTIFICATION AND CLASSIFICATION OF GAS EXPORT AND RECEIVING TERMINALS

JANUARY 2005

Since issued in print (January 2005), this booklet has been amended, latest in April 2005.
See the reference to "Amendments and Corrections" on the next page.

DET NORSKE VERITAS

FOREWORD

DET NORSKE VERITAS (DNV) is an autonomous and independent foundation with the objectives of safeguarding life, property and the environment, at sea and onshore. DNV undertakes classification, certification, and other verification and consultancy services relating to quality of ships, offshore units and installations, and onshore industries worldwide, and carries out research in relation to these functions.

DNV Offshore Codes consist of a three level hierarchy of documents:

— *Offshore Service Specifications.* Provide principles and procedures of DNV classification, certification, verification and consultancy services.
— *Offshore Standards.* Provide technical provisions and acceptance criteria for general use by the offshore industry as well as the technical basis for DNV offshore services.
— *Recommended Practices.* Provide proven technology and sound engineering practice as well as guidance for the higher level Offshore Service Specifications and Offshore Standards.

DNV Offshore Codes are offered within the following areas:

A) Qualification, Quality and Safety Methodology

B) Materials Technology

C) Structures

D) Systems

E) Special Facilities

F) Pipelines and Risers

G) Asset Operation

H) Marine Operations

J) Wind Turbines

Amendments and Corrections

This document is valid until superseded by a new revision. Minor amendments and corrections will be published in a separate document normally updated twice per year (April and October).

For a complete listing of the changes, see the “Amendments and Corrections” document located at:
http://webshop.dnv.com/global/, under category “Offshore Codes”.

The electronic web-versions of the DNV Offshore Codes will be regularly updated to include these amendments and corrections.

Comments may be sent by e-mail to *rules@dnv.com*
For subscription orders or information about subscription terms, please use *distribution@dnv.com*
Comprehensive information about DNV services, research and publications can be found at http://www.dnv.com, or can be obtained from DNV, Veritasveien 1, NO-1322 Høvik, Norway; Tel +47 67 57 99 00, Fax +47 67 57 99 11.

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INTRODUCTION

This Service Specification was approved by the Executive Board in November 2004.

The new OSS is intended to assist the industry in deciding what types and levels of qualification and assurance programs are needed for these new applications, from concept to construction to operation.

This document refers primarily to concepts involving liquefied natural gas (LNG), it may also be used for other terminal and offshore installation solutions such as those involving liquefied petroleum gas (LPG), compressed natural gas (CNG), and gas to liquids (GTL) products. Offshore terminals may be fixed or floating, and will be mainly constructed in steel or in concrete.

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SECTION 1
INTRODUCTION

A. Introduction

A 100 General

101 This Offshore Service Specification presents DNV services with respect to Risk Based Verification, Classification and Certification of offshore gas terminals. It also clarifies the role of risk assessment and qualification of technology within these services.

A 200 Organisation of this Offshore Service Specification

201 This document is divided into two main sections:

— Section 1 provides a general introduction
— Section 2 describes the various services DNV offers

A 300 Objects covered

301 Although this document refers primarily to concepts involving liquefied natural gas (LNG), it may also be used for other terminal and offshore installation solutions such as those involving liquefied petroleum gas (LPG), compressed natural gas (CNG), and gas to liquids (GTL) products.

302 Offshore terminals may be fixed or floating, and may be mainly constructed in steel or in concrete. Several different terms are used in describing LNG import and export terminals.

303 An offshore terminal which processes hydrocarbons and refrigerates gas to produce LNG will be termed here an export terminal. Where this is a floating installation, this may also be termed either an FLNG installation (floating LNG) or an LNG FPSO (LNG floating production, storage and offloading unit). The installation may be fed gas directly from a gas well or may process associated gas in conjunction with oil production.

304 An offshore terminal which receives and regasifies LNG to provide gas to the market gas grid will be termed here, a receiving or import terminal. Where the terminal is a bottom fixed concrete design it may be termed a CGBS (Concrete Gravity Based Structure). Where the terminal is a floating installation it may also be termed an FSRU (floating storage and regasification unit).

A 400 DNV Document hierarchy

401 DNV Offshore Publications which provide information at various levels of detail for offshore installations are organized into a three level document hierarchy, illustrated in Figure 1:

— Offshore Service Specifications (OSS series)
providing principles and procedures of classification, verification and consultancy services
— Offshore Standards (OS series)
specifying technical requirements and acceptance criteria for general use by the offshore industry as well as providing the technical basis for classification
— Recommended Practices (RP series)
providing sound engineering practice as well as guidance related to the higher level Offshore Publications.

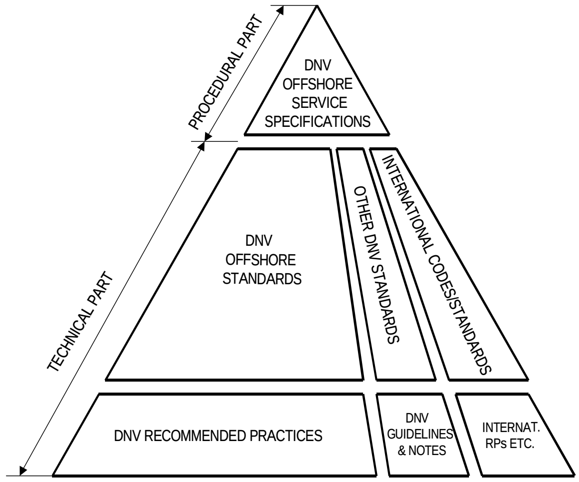


Figure 1
DNV Offshore Publication Hierarchy

402 In addition to these three levels of documentation DNV also issues Offshore Technical Guidance (OTG) on specific subjects.

403 This document will also make reference to relevant documents in the DNV document hierarchy and where appropriate to internationally accepted codes and standards.

404 These documents include the following DNV publications :

DNV Documents Relevant for LNG Terminals	
Reference	*Title*
DNV-OTG-02	Offshore Gas Export and Receiving Terminals
DNV-OSS-300	Risk Based Verification
DNV-OSS-301	Certification and Verification of Pipelines
DNV-OSS-102	Rules for Classification of Floating Production and Storage Units
DNV-OS-B101	Metallic Materials
DNV-OS-C101	Design of Offshore Steel Structures, General (LRFD method)
DNV-OS-C102	Structural Design of Offshore Ships
DNV-OS-C502	Offshore Concrete Structures
DNV-OS-C503	Concrete LNG Terminal Structure and Containment Systems
DNV-OS-C301	Stability and Watertight Integrity
DNV-OS-C401	Fabrication and Testing of Offshore Structures
DNV-OS-D101	Marine and Machinery Systems and Equipment
DNV-OS-D201	Electrical Installations
DNV-OS-D202	Instrumentation and Telecommunication Systems
DNV-OS-D301	Fire Protection
DNV-OS-E201	Hydrocarbon Production Plant
DNV-OS-E301	Position Mooring
DNV-OS-E401	Helicopter Decks
DNV-OS-F201	Dynamic Risers
DNV-OS-F101	Submarine Pipeline Systems
DNV-RP-A203	Qualification Procedures for New Technology
DNV-RP-C204	Design against Accidental Loads
DNV Rules	DNV Rules for Planning and Execution of Marine Operations

405 All documents in the DNV hierarchy may be freely accessed via our website dnv.com.

A 500 International standards

501 Internationally recognised standards may also be used in design and construction of offshore terminals these may include (others may be directly referenced in individual DNV Offshore Standards):

502 Process Systems :

Code	*Title*
NFPA 59A	Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)
TEMA	Tubular Exchanger Manufacturers Association
NFPA 37	Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines
ASME VIII	Boiler and Pressure Vessel Code
API RP 14C	Analysis, Design, Installation and Testing of Basic Surface Safety Systems for Offshore Production Platforms
API RP 520	Sizing, Selection and Installation of Pressure Relieving Devices in Refineries
API RP 521	Guide for Pressure Relieving and Depressurising Systems
API Std 610	Centrifugal Pumps for Petroleum, Heavy Duty Chemical and Gas Industry Services
API Std 6D	Specification for Pipeline Valves
API Std 617	Axial and Centrifugal Compressors and Expander Compressors for Petroleum, Chemical and Gas Industry Services
API Std 618	Reciprocating Compressors for Petroleum, Chemical and Gas Industry Services
API Std 619	Rotary Type Positive Displacement Compressors for Petroleum, Chemical and Gas Industry Services
ASME B31.3	Process Piping
AGA Report 3	Orifice Metering of Natural Gas
AGA Report 3	Fuel Gas Energy Metering
AGA Report 3	Measurement of Gas by Turbine Meters

503 LNG Transfer System

Code	*Title*
NFPA 59A (Chap 8)	Standard for Production, Storage and handling of Liquefied Natural Gas
OCIMF	Design and Construction Specification for Marine Loading Arms, 3rd ed 1999
SIGTTO/ICS/OCIMF	Ship to Ship Transfer Guide (Liquefied Gas), 2nd ed. 1995,
ICS	Tanker Safety Guide (Liquefied Gas), 2nd ed. 1995
SIGTTO	Liquefied Gas Handling Principles on Ships and in Terminals, 2nd ed. 1996,
OCIMF	Mooring Equipment Guidelines, 2nd ed. 1997

SECTION 2
VERIFICATION, CLASSIFICATION AND CERTIFICATION SERVICES

A. Principles of Verification, Certification and Classification

A 100 Definitions

101 Verification is defined as confirmation by examination and provision of objective evidence that specified requirements have been fulfilled (ISO 8402: 1994).Verification constitutes a systematic and independent examination of the various phases in the life of an asset to determine whether it is (or continues to be) in compliance with some or all of the asset specifications.

102 In the context of offshore projects we may use the following terms depending on the terms of reference of the verification contract:

— *General Verification*
In this case the verification involves a compliance check against client-defined requirements. These requirements may or may not include DNV Offshore Standards, and will typically include company standards and internationally recognized codes and standards. Verification may extend to some or all project phases depending on the agreed scope.
In this approach DNV acts in the capacity of either a 2nd party (as part of the client's organization) or 3rd party (independent of the client organization)

— *Certification*
Certification is Verification for which the deliverable includes the issue of a Certificate. In this Guidance when Certification is used it designates the overall scope of work or multiple activities for the issue of a Certificate (typically including both design and construction phases), whilst Verification may have a similar scope but may also be used for individual activities associated with the total work. Certification is performed as a 3rd party service, Verification may be performed as either a 3rd Party or a 2nd Party activity.

— *Statutory Certification*
This is defined as a compliance check against the technical requirements of a third party regulatory body. This will typically be the requirements of the shelf state where the offshore terminal is located. It may also include requirements of maritime administrations where floating installations are involved, either during transit or as a supplement to the shelf state when installed. Statutory Certification will typically require to be maintained during the life of the installation. DNV acts as a 3rd party where statutory certification is involved (Reference Sec.4 A300 with regard to typical flag state scope).
Requirement from authorities may be either mainly prescriptive (e.g. U.S., Canada) or mainly functional and risk based (e.g. U.K., Norway, Australia). In either case the verification approach can be adapted to accommodate the regulatory philosophy.

— *Classification*
Classification is defined as verification according to DNV rules, where on completion, a DNV Classification Certificate is issued. Classification is always a 3rd party activity. Classification usually implies involvement in all project phases, from design to the operations phase, however this may be specially agreed for an individual contract. The basis of the verification will be DNV Offshore Standards referred to in the DNV Rules. It should be noted that international codes and standards will normally be used as a supplement to the Offshore Codes and where found equivalent may be permitted to replace them. Classification has been traditionally a prescriptive approach, however for novel technology, existing experience is supplemented with risk assessment.
If desired the Classification approach may adopt a purely risk-based method to define the Classification requirements rather than using the existing prescriptive requirements. This approach is described in DNV-OSS-121 "Classification Based on Performance Criteria Determined from Risk Assessment Methodology"

— *Risk-Based Verification*
Instead of using an approach based on prescriptive requirements, project verification requirements may be derived from use of risk assessment technology. Risk Based Verification is a structured, systematic process of using risk analysis and cost-benefit analysis shall strike a balance between technical and operational issues and between safety and cost.
The RBV methodology contains the following steps:

— Hazard identification
— Risk assessment
— Evaluation of risk-control options
— Recommendations for decision-making
— Development of verification plan
— Performance of verification.

This approach is described in DNV-OSS-300 "Risk Based Verification".

— *Qualification of Technology*
Gas terminal concepts may involve use of novel technology or novel application of existing technology. Such technology may not be adequately addressed by existing codes and standards. In order to verify that such technology meets desired levels of safety and reliability it is necessary to assess it in a structured manner so that all potential hazards are addressed.
This methodology is described in DNV-RP-A203 Qualification Procedures for New Technology

A 200 DNV Deliverables

201 Depending on the service carried out by DNV, the final conclusion will be documented by a specific agreed deliverable. Typically these deliverables will be termed as follows in 202-205.

202 Verification according to shelf state regimes and Operator's specifications

— Verification Report on Design
— Statement of Compliance
— Certificate of Conformity.

203 Classification according to DNV Rules and additional statutory work on behalf of authorities:

— Class Certificates
— Approval in Principle
— Product Certificates for Components and Assemblies
— Survey Reports.

204 Verification services according to client's request

— DNV Verification Reports.

205 Qualification and testing of new technology, including components and systems

— Statement of Feasibility
— Statement of Fitness for Service.

206 These documents will make reference to the standards, regulations and other specifications which have formed the basis of the verification, and will be backed up by a traceable record documenting the information considered and the considerations made in arriving at the final status of the verification work.

A 300 Selection of verification approach

301 It should be noted that the verification approaches described above have a certain degree of flexibility and the selected agreed method in a particular project may involve combinations of several approaches. For example General Verification may have a scope similar to Classification, without the issue of a Class Certificate. Similarly Statutory Certification requirements may be incorporated into a General Verification approach. The exact scope of verification and the desired document deliverables should be agreed with DNV on a case-to-case basis.

302 Approaches based on prescriptive requirements and those based on risk assessment, are not totally mutually exclusive. Classification while traditionally employing prescriptive requirements recognises that in order to keep up with the pace of technological progress, it will need to supplement and calibrate these requirements with requirements based on risk analysis, when classification is applied to a non “standard” concept.

303 A Risk Based Verification approach although it adopts a “first principles” approach to design by defining requirements relevant for the specific project in question, will make use of existing codes and design methods where these are available. For example a requirement to design a floating installation to a safe standard will usually mean employing many aspects of traditional maritime design methods.

304 In both instances it may be necessary to comply with specific prescriptive requirements from statutory authorities in order to ensure final regulatory compliance for the project. This would then form the basis of a verification engagement, where a certificate needs to be issued.

305 Whether a project opts for one or other of the approaches to verification described in this section will depend on a number of inter-related factors:

— *Overall verification plan*

The verification carried out by DNV will be a part of the larger verification needs of the project. The selected verification approach will therefore be related to the verification intended to be carried out by the Operator himself and that which may be carried out by other designated parties. It is an advantage if as much verification as possible is carried out using a similar methodology to ensure a consistent level which is easily traceable.

— *Level of independence of verifier*

The verifier may be a part of the client’s organization or may be a third party. Any verification however should maintain a separation from the organizational unit carrying out the actual work to be verified. Separation and independence however may still be achieved while the verifier works in close cooperation with the project.

— *Regulatory requirements*

Regulatory authorities may have specific requirements to verification, and may define a minimum scope for verification (e.g. U.S. CVA scope) or certification. This would then form the basis of a verification engagement.

— *Degree of Novelty*

The greater the degree of novelty the greater the incentive to use risk assessment techniques to ensure that all novel aspects are adequately covered.

SECTION 3
VERIFICATION/CERTIFICATION OF OFFSHORE TERMINALS

A. Principles of Verification/Certification of Offshore Terminals

A 100 General

101 Verification should be based on an agreed scope with agreed references. These references may include international codes and standards and Operator specifications and will typically also be influenced by regulatory requirements. The approach may be either primarily prescriptive or primarily risk based. However for offshore terminals there does not exist at present a fully comprehensive prescriptive standard which adequately addresses the gap between codes intended for similar land-based or marine applications. Therefore it will be necessary to use existing related standards as far as applicable, adopt a first principles approach for some aspects and also to make use of risk methodology.

102 Verification may also be termed Certification, when applied to both design and construction phases and when the final verification statement is a Certificate. The terms may be interchanged in the text below which uses only the term Verification.

A 200 Use of recognised standards

201 Ideally a project would like to base a design on a set of predictable requirements incorporated into an internationally recognized standard. In the case of novel concepts however there will be a lag before new codes are developed or existing codes are updated in order to address all important aspects of an emerging technology. In the meantime it may be necessary to try to identify relevant requirements in existing codes and adapt them to the new technology.

202 Codes and standards aim at a certain safety level (usually implicitly) and arrive at that level by specifying requirements to a number of parameters which impact safety. These parameters for example may include :

— method of analysis
— level of analysis
— safety factor or load/material factor
— material quality
— fabrication quality
— extent of NDE
— extent of testing
— qualification of personnel.

203 Different codes within the same technical area may achieve the same level of safety by varying the emphasis on the above parameters, for example more rigorous analysis methods or more rigorous fabrication control instead of reliance on a single safety factor. Selection of parts of a code or mixing of requirements from several codes may therefore not necessarily give the intended level of safety.

204 Many codes contain non-obvious assumptions which if not adhered to may invalidate the level of safety represented by the code. For example, use of ship hull structures in an offshore terminal design will need to take account of the possibility of inspection in situ or the impossibility of inspection compared to a similar gas carrier design which may be taken out of service or moved to calmer waters or a shipyard for rework or repair.

205 With regard to design of LNG terminals or CNG vessels there will be a mixture of a number of relevant technologies:

— land based LNG liquefaction or regasification plant
— land based LNG containment tanks
— marine LNG containment tanks
— marine vessel safety features
— marine vessel design
— offshore oil and gas production installations
— pipeline design.

206 Selection of the best of the above technologies and their codes in combination will therefore represent a challenge. In addition to the considerations above on selecting from codes, there is also the probability that code requirements intended for a particular technology will not be appropriate when that technology is used in a novel way. The code may not adequately account for new hazards introduced in the new application, or indeed may address hazards no longer relevant in the new application. There is therefore the risk that a design based on existing prescriptive codes will be either non-conservative or possibly overly conservative. At any rate there may be uncertainty about the level of safety achieved.

207 In order to ensure that all relevant hazards are adequately addressed in technology projects without a specific service history, suitable for the intended application, it will be necessary to:

— consider existing code requirements based on their intent and context
— supplement existing prescriptive requirements with risk assessment methodology in order to identify and address novel risks.

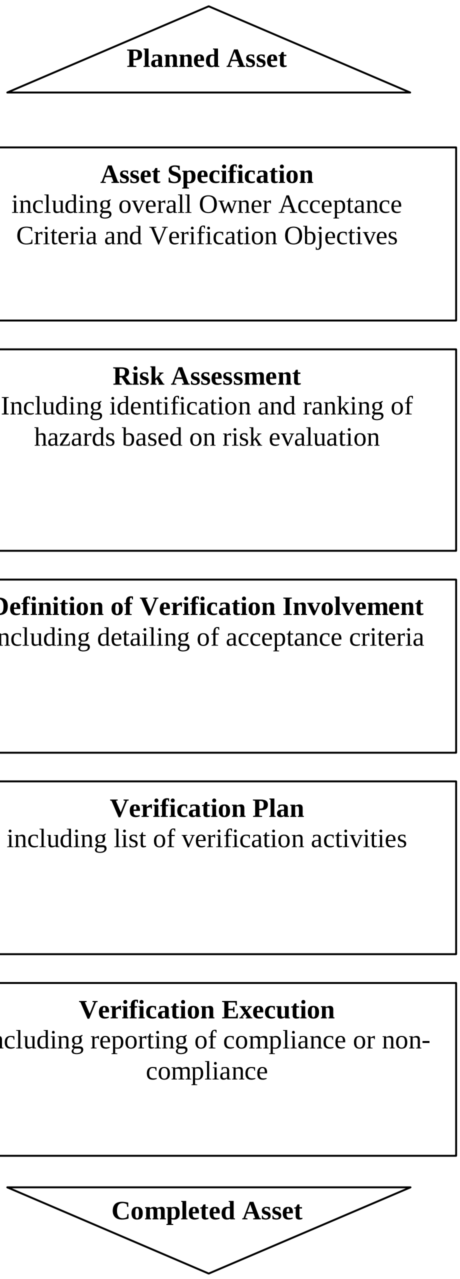
208 In considering major subsystems and components which are of novel design or which employ existing designs in a manner not originally anticipated by a relevant code or standard, a structured evaluation of the novel use and novel hazards will be necessary. This is further described in Sec.10, Qualification of New Technology.

209 Below is described a means of carrying out verification based on risk assessment techniques. This will provide a methodology to identify the relevant risks associated with a terminal design and may use existing code requirements to address these where such requirements are considered applicable and adequate. Assessment of adequacy of requirements will be an integral part of the overall verification.

A 300 Risk Based Verification (RBV)

301 The RBV approach is build on the basic assumption that the parties involved (e.g. designers, manufacturers, contractors, operators) undertake sufficient and suitable assurance activities to ensure the suitability of the asset; RBV is not a substitute for other parties' roles or obligations.

302 The figure below illustrates the purpose of the verification and the major steps involved in achieving the end result. Essentially the project aims to ensure that the completed asset complies with the principles set forth for the planned asset.



303 The Verification Contractor's role, which DNV offers, in executing RBV will typically be through contributions in one or more of the following areas:

- assist in development of project SHE philosophy, and asset specification
- participate in HAZIDs
- review risk assessments and / or detailed studies to identify the critical aspects
- assist with development of, or develop, performance-based requirements
- review customer's safety assessment to confirm that the process is adequate and robust
- incorporating performance-based requirements in a verification activity plan
- implementation of the verification activity plan.

304 Adequate quality management systems will need to be implemented to ensure that gross errors in the work of design, construction and operations are limited.

305 Factors to be considered when evaluating the adequacy of a quality management system include:

- whether or not an ISO 9000 or equivalent certified system is in place
- results from external audits
- results from internal audits
- experience with contractors' previous work
- project work-force familiarity with the quality management system, e.g. has there been a rapid expansion of the work force or are all parties of a joint venture familiar with the same system?

306 Risk Based Verification may be based on either a relatively simplified approach based on qualitative evaluation of the asset using trigger questions and predefined checklists or alternatively may be based on a detailed analytic approach, depending on what is considered most appropriate for the project in question.

307 A detailed analytic approach to Risk Based Verification at its most comprehensive level comprises the following six main elements:

- risk assessment
- identification of the major hazards
- identification of key risk elements
- identification and/or development of acceptance criteria
- development of a verification plan
- implementation of the verification plan.

308 Both the simplified and the detailed approach will lead to the development of a verification plan, which will describe the various verification activities which will be carried out and the level of that verification.

309 Three levels of verification, as shown in Figure 1, may be selected in RBV. The verification level can be selected by Owner or Verification Contractor, depending on the service required and the detailed requirements of local Authorities.

310 Factors to be considered in the selection and definition of verification level include:

- degree of complexity in achieving technical requirements,
- experience with similar facilities
- EPC contractors general experience, and experience in similar work.

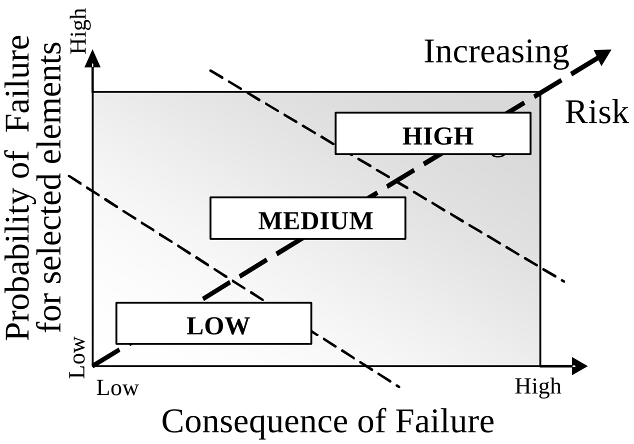


Figure 1
Levels of verification

311 Some general principles regarding selection of the level of verification are shown in Table 1.

Table 1 Levels of Verification and Guidance on Involvement of Verifier

Level	**System Characteristics**	**Description of typical verification**
Low	— Proven designs with relatively harmless content and/or installed in benign environmental conditions — State of the art design, manufacturing and installation by experienced contractors — Low consequences of failure from a commercial, safety or environmental point of view. — Relaxed to normal completion schedule	Review of Design Basis and General Principles and production systems during design and construction. Review of principal design documents, construction procedures and qualification reports. Site attendance only during system testing. Less comprehensive involvement than level Medium.
Medium	— Asset in moderate or well controlled environmental conditions — Plants with a moderate degree of novelty — Medium consequences of failure from a commercial, safety or environmental point of view. — Normal completion schedule	Review of Design Basis and General Principles and production systems during design and construction. Detailed review of principal and other selected design document with support of simplified independent analyses. Full time attendance during (procedure) qualification and review of the resulting reports. Audit based or intermittent presence at site.
High	— Innovative designs — Extreme environmental conditions — Plants with a high degree of novelty or large leaps in technology — Contractors with limited similar experience or exceptionally tight completion schedule — Very high consequences of failure from a commercial, safety or environmental point of view.	Review of General Principles and production systems during design and construction. Detailed review of most design document with support of simplified and advanced independent analyses. Full time attendance during (procedure) qualification and review of the resulting reports. Full time presence at site for most activities. More comprehensive involvement than level Medium.

312 A Verification Plan must be developed to formalise the approach to verifying the critical aspects of an asset. The plan will describe the verification to be carried out during the design phase, the construction phase, during installation and commissioning and during the operations phase.

313 The Verification plan should clearly identify responsibility for carrying out various activities and when they are to be carried out.

314 Design verification shall confirm that a chosen design is in conformity with the acceptance criteria (i.e. project specifications, regulations of national authorities and international standards and guidelines).

315 The design verification process will provide feedback and early identification to the project for the areas of concern and contribute to practical solutions regarding design and construction problems that may arise.

316 The information required for the monitoring and examination of the fabrication and construction process will be partly dependent on previous steps in the RBV plan.

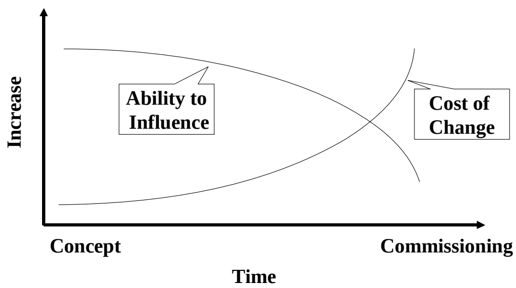
Typically, the following information is required to monitor and examine the fabrication and construction processes and product compliance:

— quality plan,
— construction specifications, construction method, etc.,
— tolerances and dimensional control procedures,
— material specifications,
— test programs and commissioning activities.

317 In the event that the project requirements specify that the fabrication contractors, sub-contractors and suppliers shall be evaluated to demonstrate their quality ability to meet specified requirements and expectations, a formal review, such as a Manufacturer Product Quality Assessment (MPQA), may be performed, if desired by the Client.

318 The Verification Plan should also reflect the fact that any modifications which need to be carried out are best identified and implemented as early as possible in a project. The typical relationship between Cost of Change and Project Time is illustrated in the figure below.

319 For further details of the Risk Based Verification approach reference is made to DNV publication , DNV-OSS-300 Risk Based Verification.



SECTION 4
CLASSIFICATION OF OFFSHORE TERMINALS

A. Principles of Classification of Offshore Terminals

A 100 Introduction

101 Classification is a comprehensive verification service providing assurance that a set of requirements laid down in rules established by DNV are met during design and construction, and maintained during operation of an offshore unit or installation. Classification has gained world-wide recognition as representing an acceptable level of safety and quality.

102 Classification implies an activity, in which an offshore installation, in this case a terminal, is surveyed by DNV during construction on the basis of design approval, tested before being taken into service, and surveyed regularly during its whole operational life. The aim is to verify that the required safety standard is built-in, observed and maintained.

103 The rules which are in force at the date of the written request for classification, are the basis for the assignment and maintenance of class. In exceptional cases, where unacceptable service experience and/or theoretical findings clearly show that safety hazards may arise in connection with items covered by the existing rules, DNV may lay down supplementary requirements to maintain the overall safety standard reflected by the rules.

104 While the rules contain many prescriptive requirements, the rules also call for use of risk assessment to address novel aspects and novel applications of known technology.

105 While the basis for classification of an offshore terminal is DNV Rules and Standards, DNV will also consider alternatives to requirements contained in the Rules if they are found to maintain the overall safety standard represented by the rules.

106 Where an offshore installation is covered by detailed technical legislation of either a flag state, as could be the case for some floating terminals, or the shelf state, the requirements of such bodies may form the basis for assigning class. It should also be noted that a flag state may also act as a port state with respect to offshore terminals (floating or fixed), so that the maritime administration may be the leading authority with regard to offshore terminals.

107 Following satisfactory design and construction of an offshore terminal a Classification Certificate is issued.

108 In order to maintain Class the terminal needs to be satisfactorily maintained and modifications adequately addressed. This is confirmed by annual and periodic surveys.

A 200 Scope of classification

201 Classification comprises mandatory elements and voluntary elements. Typically the main structure and storage and machinery and systems critical to maintaining their safety will be subject to mandatory coverage by Class. Equipment and systems for processing of gas, i.e. liquefaction or regasification plant, may be covered by Class on a voluntary basis. If such systems are not covered by Class it is assumed that they are covered by a separate verification system to a satisfactory level.

202 For mandatory class items, there may be cases where the client wishes to limit the scope of classification to selected areas and items only. Such special class arrangements may be acceptable provided it can be demonstrated that areas and items not covered by classification have, or will be, designed, constructed and maintained to an appropriate recognised standard. The involvement by DNV will be specified in the class agreement and reflected in the class notations for the installation.

203 The rules and standards referred to in the Class Agreement define acceptance criteria for design, construction, survey and testing of offshore installations, their machinery and utility installations, systems and equipment, applicable to the newbuilding and operational phases.

204 These rules, together with referenced standards, give requirements in the following areas (some items dependant on whether floating or fixed):

- *Structure*
  - arrangement
  - strength
  - containment system structure
  - support for gas processing plant
  - offloading structures
  - materials and welding
  - corrosion protection
  - tank arrangement
  - weathertight and watertight integrity
  - stability and floatability
  - foundation.
- *Marine, machinery and utility installations and equipment*
  - power generation and distribution
  - drainage and bilge pumping
  - ballasting
  - anchoring and mooring
  - pressure vessels and high pressure piping in Hull/ main structure (if relevant)
  - drains from topsides or other systems which might affect hull/main structure safety
- *Safety Systems*
  - area classification
  - emergency power
  - emergency shut-down
  - escape routes
  - fire and gas detection and alarm
  - fire fighting
  - communication (alarm, public address)
  - structural fire protection (including penetrations)
  - control systems for safety systems (including UPS arrangement)
  - HVAC including ventilation in hazardous areas.

205 The listing above does not include the gas processing plant (LNG, LPG or GTL) or the loading/offloading arrangement. These, and other areas such as cranes, helideck, which are not considered as part of the minimum scope of class, may be included in the Class scope on agreement with the client.

206 Classification generally does not cover aspects such as lifesaving and evacuation equipment, pollution prevention equipment. These are typically covered for offshore installations by flag or shelf states. However if the operator wishes the class society to address such areas, this can be included as an addition to the standard class scope. This typically needs to be coordinated with other regulatory authorities who may wish to have an active role in these matters.

A 300 Flag/ maritime administration considerations

301 Generally the flag state or maritime administration has requirements within the following areas, some of which are fully or partially covered by the classification scope. Even if an installation is not floating, the maritime administration may have full or partial authority over the offshore installation.

— Lifeboats and other life saving equipment
— Escape ways
— Load Line marking
— Pollution Prevention/Oily water system
— Helideck and Helifuel system
— Aids to Navigation
— Emergency communication
— Emergency Power*
— Emergency Lighting*
— Stability*
— Structure*
— Firefighting/Fire Protection*
— Fire detection*
— Lifting Appliances
— Working Environment

*parallel scope to Class (usually equivalent with exceptions for a few flag states)

B. Class Notations

B 100 General

101 To reflect the scope covered by the Class Agreement, DNV will assign Class notations to the offshore terminal.

102 Classed units and installations will be given a class designation consisting of:

— construction symbol
— main character of class
— basic design notation
— service notation
— system and special facility notations (as applicable)
— special feature notations (as applicable).

103 A typical class notation for an offshore LNG terminal would be:

✠ OI Floating Offshore LNG Liquefaction Terminal

or

✠ OI Fixed Offshore LNG Regasification Terminal

Where the terms are clarified as follows :

B 200 Construction symbols

The symbol ✠ will be given to units and installations built under the supervision of DNV.

The symbol ✠̇ will be given to units and installations built under the supervision of a recognised classification society and later assigned class with DNV.

B 300 Main character of class

301 The notation **OI** will be given to non-self-propelled floating offshore installations intended for service at one offshore location with main structure, utility and safety systems found to be in compliance with the basic requirements of the applicable DNV offshore standards referred to in the rules.

The notation **OI** will also be given to fixed offshore installations intended for service at one offshore location with main structure, utility and safety systems found to be in compliance with the basic requirements of the applicable DNV offshore standards referred to in the rules.

B 400 Basic design notations

401 The basic design notation indicates the type of structure.

Table B1 Basic design notations

Basic design notation	*Description*
Floating Offshore Terminal	The terminal may be ship shaped or barge shaped. It may be constructed in steel or in concrete, or some combination of both.
Fixed Offshore Terminal	The terminal will be a gravity based structure, fabricated in steel or concrete or a combination of both

B 500 Service notations

501 Terminals constructed according to DNV rules for offshore classification, arranged for a particular service and found to be in accordance with the relevant requirements for such service, will be given a corresponding service notation.

Table B2 Service notations

Notation	*Description*
LNG Liquefaction	Terminal which processes gas to produce LNG as a main function
LNG Regasification	Terminal which processes LNG to produce gas for pipeline as a main function

B 600 System and special facility notations

601 Units or installations having special facilities, systems or equipment found to satisfy specified class requirements will be given a corresponding class notation. Notations currently in use are given in Table B3.

Table B3 Additional system and special facility notations

Notation	*Description*
DYNPOS-AUTS	Dynamic positioning system without redundancy
DYNPOS-AUT	Dynamic positioning system with an independent joystick back-up and a position reference back-up
DYNPOS-AUTR	Dynamic positioning system with redundancy in technical design and with an independent joystick back-up
DYNPOS-AUTRO	Dynamic positioning system with redundancy in technical design and with an independent joystick back-up. Plus a back-up dynamic positioning control system in an emergency dynamic positioning control centre, designed with physical separation for components that provide redundancy
BOW LOADING	Bow loading arrangement
CRANE	Equipped with crane(s)
DEICE or DEICE-C	Unit equipped with de-icing or anti-icing systems
E0	Unit equipped for unattended machinery space
ECO	Unit equipped for operation of machinery from centralised control station
F-A	Additional fire protection of accommodation space
F-AM	Additional fire protection of accommodation and machinery space
F-M	Additional fire protection of machinery space
F-C	Additional fire protection of cargo space
F-AC	Additional fire protection of accommodation and cargo space
F-MC	Additional fire protection of machinery and cargo space
F-AMC	Additional fire protection of accommodation, machinery and cargo space

Table B3 Additional system and special facility notations (Continued)

Notation	*Description*
HELDK	Helicopter deck structure
HELDK-S	Helicopter deck structure including safety aspects related to the unit
HELDK-SH	Helicopter deck structure including safety aspects related to the unit and to the helicopter
HELDK-SHF	Helicopter deck structure and safety aspects related to the unit and to the helicopter, including on board helicopter service facilities
HMON-1	Provided with basic hull monitoring system
HMON-2	Provided with comprehensive hull monitoring incorporating measurement of environmental conditions
ICE-L	Strengthened for ice condition operation
ICS	Unit equipped with integrated computer system
OFFLOADING	Hydrocarbon or LNG offloading system
POSMOOR	Passive position mooring system
POSMOOR-V	Mooring system designed for positioning in the vicinity of other structures
POSMOOR-TA	Thruster assisted mooring system dependent on manual remote thrust control system
POSMOOR-ATA	Thruster assisted mooring system dependent on automatic remote thrust control system
PROD	Hydrocarbon production plant
Liquefaction Plant (LNG)	LNG Liquefaction Plant is designed and constructed in accordance with Class requirements as reflected in DNV-OS-E201 and recognized international standards
Liquefaction Plant (LPG)	LPG Liquefaction Plant is designed and constructed in accordance with Class requirements as reflected in DNV-OS-E201 and recognized international standards
GTL Plant	The Gas to Liquids processing plant is designed and constructed in accordance with Class requirements as reflected in DNV-OS-E201 and recognized international standards
CNG Plant	The terminal, either export or receiving, has plant for loading or unloading from a CNG Carrier. The plant is designed and constructed in accordance with Class requirements as reflected in DNV Rules for Ships Pt.5 Ch.15 and recognized international standards (Note the CNG carrier is covered by separate class notation)
Regasification Plant	Regasification Plant is designed and constructed in accordance with Class requirements as reflected in DNV-OS-E201 and recognized international standards
SBM	Unit with implemented management system
SPM	Single point mooring
STL	Submerged turret loading
VCS-1, VCS-2 or **VCS-3**	System for control of vapour emission from cargo tanks

B 700 Special feature notations

701 Special feature notations provide information regarding special design assumptions, arrangements or equipment which is not covered by other class notations.

Relevant special feature notations currently in use are listed in Table B4.

Table B4 Special feature notations

Notation	*Description*
COAT-1 COAT-2	Specification of corrosion prevention in ballast tanks

B 800 Limitations of class

801 When the client for an **OI** classed installation wishes to limit the scope of classification to selected areas and items only, the parts of the installation which are covered by classification will be indicated in the classification certificate. The purpose of the notation Limitation of Class shall indicate such limitations, if applicable

Example:

— Structure: Classification is limited to cover main structure.

B 900 Typical terminal class notations

901 Notations which would be typical for offshore receiving and export terminals would be as follows (these are arbitrary examples which include both mandatory and non-mandatory notations) :

Table B5 Terminal Class Notations

Notation	*Description*
✠ OI Floating Offshore LNG Liquefaction Terminal, POSMOOR	The terminal may be ship shaped or barge shaped. It may be constructed in steel or in concrete, or some combination of both. It will receive gas from wells and liquefy and store it before transferring it to a gas carrier. May also be termed an LNG FPSO. The mooring system is covered by Class.
✠ OI Fixed Offshore LNG Liquefaction Terminal, Liquefaction Plant, CRANE	The terminal will be a gravity based structure, fabricated in steel or concrete or a combination of both. It will receive gas from wells and liquefy and store it before transferring it to a gas carrier. Both the cranes and the liquefaction plant are voluntarily covered by Class.
✠ OI Floating Offshore LNG Regasification Terminal, POSMOOR , Regasification Plant	The terminal may be ship shaped or barge shaped. It may be constructed in steel or in concrete, or some combination of both. It will receive liquefied gas from a gas carrier, store it before regasifying it and sending it to a gas pipeline. It may also be termed an FSRU. The mooring system is covered by Class. The regasification plant is also voluntarily covered by Class.
✠ OI Fixed Offshore LNG Regasification Terminal	The terminal will be a gravity based structure, fabricated in steel or concrete or a combination of both. It will receive liquefied gas from a gas carrier, store it before regasifying it and sending it to a gas pipeline.

902 For types of terminals not properly characterised by the listed notations, the basic notation:

✠ OI Offshore Gas Terminal

may be used. This could cover, for example, a terminal, floating or fixed, which receives gas which is delivered as Compressed Natural Gas. Similarly LNG could be replaced by LPG where this is the product or by LNG/LPG where both are produced. Where the gas liquefaction, regasification or handling plant is also covered by Class, this would be reflected in an additional system and special facility notation as listed above.

C. Assignment of Class

C 100 Request for classification

101 A request for classification shall be submitted in writing by the client and the Class notations agreed by DNV and the client.

C 200 Offshore standards

201 The basis of Classification will be compliance with the below listed standards, unless otherwise agreed with the client.

Reference	*Title*
DNV-OSS-102	Rules for Classification of Floating Production and Storage Units
DNV-OSS-300	Risk Based Verification
DNV-OSS-301	Certification and Verification of Pipelines
DNV-OS-A101	Safety Principles and Arrangement
DNV-OS-B101	Metallic Materials
DNV-OS-C101	Design of Offshore Steel Structures, General (LRFD method)
DNV-OS-C102	Structural Design of Offshore Ships
DNV-OS-C502	Offshore Concrete Structures
DNV-OS-C503	Concrete LNG Terminal Structures and Containment Systems
DNV-OS-C301	Stability and Watertight Integrity
DNV-OS-C401	Fabrication and Testing of Offshore Structures
DNV-OS-D101	Marine and Machinery Systems and Equipment
DNV-OS-D201	Electrical Installations
DNV-OS-D202	Instrumentation and Telecommunication Systems
DNV-OS-D301	Fire Protection
DNV-OS-E201	Hydrocarbon Production Plant
DNV-OS-E301	Position Mooring
DNV-OS-E401	Helicopter Decks
DNV-OS-F101	Submarine Pipeline Systems
DNV-OS-F201	Dynamic Risers
DNV-RP-A203	Qualification Procedures for New Technology
DNV-RP-C204	Design against Accidental Loads
DNV Rules	Rules for Planning and Execution of Marine Operations

202 The following Recommended practices and other references should be used :

Table C2 DNV recommended practices and other references	
Reference	*Title*
DNV-RP-A201	Standard Documentation Types
DNV-RP-A202	Documentation of Offshore Projects
ICG Code	The International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk, as amended
NFPA 59A	Standard for the Production, Storage, and Handling of Liquefied Natural gas (LNG)
EN 1473	Installation and Equipment for liquefied natural gas. Design of onshore installations
DNV-RP-C204	Design against Accidental Loads
DNV-OTG-02	Offshore Gas Export and Receiving Terminals

203 Other codes and standards, such as those listed in Section 1 , may also be applied on agreement between DNV and the Client.

204 Please note the discussion concerning challenges in using related standards and parts of standards for a novel application in Sec.3 A200.

C 300 Requirements for workshops and yards

301 Clients shall operate a quality management system applicable to the scope of their work. The system shall be documented and contain descriptions and procedures for quality critical aspects. Clients unknown to DNV shall demonstrate their capability to carry out fabrication of adequate quality in accordance with the rules before construction is started.

302 Welding of important structures, machinery installations and equipment shall be carried out by approved welders, with approved welding consumables and at welding shops accepted by DNV.

303 During fabrication and construction work, DNV surveyors shall have safe access to the works at all reasonable times, insofar as the work affects classification. The client shall ensure, through contracts with the parties concerned or otherwise, that such access is possible, and that DNV is notified as to when and where the surveyor's attendance is needed.

304 The following documentation from the Client (workshop and yard) and from subcontractors shall be submitted to DNV at the start of a classification project:

- list of subcontractors to the building yard
- list of suppliers of materials and components, including subcontractors if applicable.

C 400 Requirements for manufacturers

401 Manufacturers of materials, components and equipment for main class shall be approved according to criteria established by DNV, as applicable.

402 Any required quality control of materials, components and equipment, shall be traceable and documented in writing. Further, quality control shall be carried out by qualified personnel at facilities and with equipment suitable for that control.

C 500 Requirements for suppliers of services

501 Firms providing services on behalf of the owner, such as measurements, tests and maintenance of safety systems and equipment, where the results may form the basis for the surveyor's decisions, shall be approved by DNV.

502 Where surveyors use such services in making decisions affecting statutory certifications, the suppliers are subject to approval by DNV in cases where DNV is authorised by the relevant administration to do so. For such services DNV may accept approvals carried out by the administration, or duly authorised organisations acting on behalf of the administration.

503 Measuring and test equipment used in services by manufacturers, builders, repairers or owners, where the results may form the basis for the surveyor's decisions, shall have a documented calibration status.

C 600 Document approval

601 The Client (or if agreed, the builder or manufacturer) shall make available to DNV the following documentation according to documentation lists supplied by DNV upon receipt of class request, before production commences (see Section 7 for generic information requirements):

- documentation required for approval
- corresponding technical descriptions, calculations and data, including material specifications.

Any documents submitted for re-approval shall be specially marked to identify the revised parts.

602 The Client, with which DNV has the classification contract, is responsible for co-ordinating that drawings and other documents are submitted, and for distributing any approval comments that may have been given.

603 Documentation that has been found to comply with the rule requirements will be provided with a statement of approval. Conditions and limitations of the approval will be stated as agreed in the classification contract.

604 The approval may be revoked at any time if subsequent information indicates that the design solution was contrary to the rule requirements or intentions.

605 The English language shall be used in drawings and specifications submitted for approval. The possibility of using the local language shall be agreed upon in each case.

606 When drawings and documents are submitted as electronic files, the format and transfer method shall be agreed upon in each case.

C 700 Survey

701 When a unit or installation is built under the supervision of DNV, the following will be verified:

- that the construction and dimensions comply with the rule requirements and the approved documentation
- that the required materials are used
- that the materials, components and systems have been certified in accordance with the rules
- that the work is carried out in compliance with the rules and with good engineering practices
- that satisfactory tests are carried out to the extent and in the manner prescribed by the rules.

702 Supervision will be carried out at the building yard and/or the sub-suppliers at the discretion of DNV, which also decides the extent and method of control.

703 The verification method applied by DNV at the building yard or at the manufacturers will be based on a combination of audits of an accepted quality system and visual inspections and tests.

C 800 Functional testing

801 Functional tests will be carried out as deemed necessary by DNV.

802 A test programme shall be prepared by the Client/builder. The programme shall specify systems and components to be tested, and the testing procedure. The programme shall include sea trials with machinery and equipment installed (as applicable to a terminal). The tests shall give evidence of satisfactory operation in accordance with the rules. When testing the control and safety system, failure modes shall be simulated as realistically as possible.

803 Unless otherwise agreed, the testing required by the rules shall be carried out in the presence of a surveyor. Data shall be recorded according to the test programs and as considered necessary by the surveyor. All systems are expected to be inspected and tested by the builder prior to being presented for final testing.

804 Final testing after installation of the terminal on location may also be carried out . This testing is typically outside the scope of standard classification however DNV engagement may be specially agreed with the client.

C 900 Final classification documentation

901 When the surveyor is of the opinion that the requirements corresponding to the class in question have been met, he will document the completion of the building supervision by issuing the C*ertificate of Interim Class,* which is valid until the administration of DNV has confirmed the class and issued the classification certificate.

902 At the discretion of the surveyor the building supervision may be considered to be completed with some minor items unverified, provided conditions of class are issued to the effect that the remaining work, surveys or other measures shall be completed within a specified time. At the same time the surveyor will document the completion of the newbuilding supervision by issuing the Certificate of Interim Class.

903 When the administration of DNV has examined the surveyor's report and is satisfied that the requirements have been met, class will be assigned and a *Classification Certificate* will be issued.

904 Provided the requirements for maintenance of class will be complied with, and unless the class has been withdrawn in writing at an earlier stage, the *Classification Certificate* will be valid for 5 years.

905 An "*Appendix to the Classification Certificate*" will be issued stating assumptions for the assignment of class and conditions regarding the use of the unit or installation, which were established or assumed at the time of assignment of class.

C 1000 Maintenance of Classification certificate

1001 In order to maintain the Classification certificate the offshore terminal will need to undergo regular survey. Typically this will involve an annual survey and a more comprehensive 5 yearly survey. Additional surveys may need to be carried out should the terminal be significantly modified or sustain damage in the periods between regular survey.

1002 The survey timing and methods will take account, as far as possible, of the inspection and maintenance programs adopted by the Operator.

1003 Planning for the operations phase and the need for inspection and maintenance should be part of the Operators design and construction philosophy. The extent and type of survey should be discussed with DNV as part of this process.

D. Verification of Procured Items

D 100 General

101 The scope of classification includes certification of materials, components and systems intended for the unit or installation. The rules define the extent of the certification that is needed for classification. The objective of the certification shall ensure that materials, components and systems used in units or installations to be classed by DNV conform to the rules and referenced standards within the framework of the rules.

102 The certification is a conformity assessment normally including both design and production assessment. The production assessment includes inspection and testing during production and/or of the final product. The design assessment of the materials, components and systems shall either be on a "case by case" basis or follow the procedure for type approval.

D 200 Case-by case approval

201 When the "case by case" procedure is used, documentation of the design shall be submitted for assessment for every application as required in the rules. A design assessment letter or design verification report shall be issued by DNV when compliance with the requirements for the design for the actual application is confirmed. The designer must ensure that his design accounts for all relevant design loads, including accidental loads derived from any risk assessment carried out by the project.

202 The production assessment of materials, components and systems shall either be on a "case by case" basis or on the basis of an agreed Manufacturing Survey Arrangement (MSA).

203 When the "case by case" procedure is used, the survey and testing shall be performed on the basis of approved design documentation for the actual application and as required in the rules. Compliance with the approved design documentation and the requirements shall be documented through certificates as required in the rules.

204 When the production assessment is based on an MSA, the survey and testing shall be performed on the basis of approved design documentation and in accordance with requirements and procedures laid down in the MSA. Compliance with the approved design documentation and the requirements shall be documented through certificates as specified in the MSA or as required in the rules.

D 300 Type approval

301 Type approval is a procedure for design assessment. Type approval can be applied to:

— a product
— a group of products
— a system.

302 This procedure should normally be used for design assessment of standard designs.

303 When the type approval procedure is used, documentation of the design and the results of type testing as required in type approval programmes and the rules, shall be submitted for assessment. A type approval certificate shall be issued by DNV when compliance with the requirements for the design is confirmed. The type approval certificate has a validity of 2 or 4 years depending on type of material, component and system.

304 The type approval procedure will normally consist of the following elements:

— design approval
— type testing
— issuance of type approval certificate.

305 The type approval procedure used by DNV is described in DNV Standard for Certification 1.2.

306 For certain products, equipment and systems as defined in the rules, type approval is sufficient as the assessment needed for conforming product quality, i.e. production assessment is not required.

307 For certain products, equipment and systems as defined in the rules, type approval is a mandatory procedure for design assessment.

308 For products, equipment and systems manufactured for stock, type approval shall be the normal procedure for assessment of design.

309 For type approved products, where the basis for approval is the rules, documentation of the product need not be submitted for approval for each offshore unit or installation unless otherwise stated as a condition on the type approval certificate. In such cases only the arrangement or system plans, interface plans and those plans mentioned on the type approval certificate shall be submitted for approval.

D 400 Documentation of certification

401 Certification of materials, components and systems shall be documented by the following types of documents:

1) DNV Product certificate (NV):
   A document signed by a DNV surveyor stating:

   — conformity with rules or standard requirements
   — that tests are carried out on the certified product itself
   — that tests are made on samples taken from the certified product itself
   — that tests are performed in presence of the surveyor or in accordance with special agreements.

2) Works certificate (W):
   A document signed by the manufacturer stating:

   — conformity with rules or standard requirements
   — that tests are carried out on the certified product itself
   — that tests are made on samples taken from the certified product itself
   — that tests are witnessed and signed by a qualified department of the manufacturers.

3) Test report (TR):
   A document signed by the manufacturer stating:

   — conformity with rules or standard requirements
   — that tests are carried out on samples from the current production.

402 The applicable rules or standards will specify which of the above mentioned documentation will be required.

403 Where the rules require Works certificate (W) or Test report (TR), the surveyor may at any time require tests to be carried out in his presence and/or check elements of the quality control in operation.

404 For identification and traceability, certified products shall be stamped in accordance with the marking given in the product certificate and as specified by the applicable rules or standards.

405 For certain components and systems as defined in the rules, the certification may be based on defined internationally recognised standards and certification schemes that cover the overall quality, safety and environmental standard of the rules. Compliance with the requirements of the standard shall be documented as required by the standard.

D 500 Manufacturing survey arrangement

501 When the procedures and processes of a building yard's or a manufacturer's quality system meet the quality, safety and environmental standard of the rules, a manufacturing survey arrangement (MSA) may be established with the yard or the manufacturer as an alternative to the verification and production assessment described in the applicable rules.

502 The agreed MSA shall be described in a document stating the requirements, scope, acceptance criteria, documentation and the roles of DNV and the yard or the manufacturer in connection with the production assessment.

503 When it is agreed through an MSA that the majority of the required surveys and tests are being completed without the presence of a surveyor, it is conditional upon the manufacturer having in operation a quality system certified by an accredited certification body to ISO 9002, or equivalent.

504 When establishing an MSA, an initial assessment of the manufacturer's ability to control product quality and to comply with the scope, requirements and criteria laid down in the MSA shall be performed. The extent and frequency of periodical assessments of the manufacturer shall be included in the MSA.

505 An MSA is normally given a validity of 4 years. When the MSA is based on a certified quality system, the MSA automatically becomes invalid if the quality system certification is no longer valid.

E. Installations Converted to use as Offshore Terminals

E 100 General

101 Floating installations (for example existing gas carriers), or fixed installations (for example existing jacket structures) may be converted from their original use to use as offshore terminals. In such cases consideration will be given to existing design and construction documentation in assessing the continued use and novel application of such installations. The general principles described in DNV OSS 102 Appendix A will be applied for such conversions.

102 Any assessment of installations to be converted will at least include the following activities :

— survey to assess the condition of the structure
— consideration of remaining service life
— consideration of the structural design for the new loading regime
— consideration of any gaps in current and original design codes
— consideration of available documentation and service experience for existing equipment and systems.

103 New or modified structures or systems will need to be designed and constructed to the currently valid requirements.

104 Existing systems will need to be assessed for suitability for the new application as a terminal. This will consider for example changes in loading regime, increased usage, and increased consequence of failure.

F. Acceptance of control by national authorities

F 100 Principles of acceptance of control by national authorities

101 In cases where the administration of a flag state or shelf state authority reviews plans, carries out type approval, and surveys the unit or installation and/or its components and equipment in accordance with the rules requirements, consideration will be given to the acceptance of this control as basis for the assignment of class.

SECTION 5
VERIFICATION OR CERTIFICATION OF PIPELINE SYSTEMS

A. Principles of Verification or Certification of Pipeline Systems

A 100 General

101 For import terminals the pipeline connecting the terminal to the shore gas grid may also be considered as an integral part of the terminal.

102 Pipelines will also be subject to regulatory requirements.

103 The pipeline may be covered by DNV verification activities. DNV verification of the complete design and fabrication phases results in the issue of a Certificate for the pipeline.

104 The essential difference between the terms Certification and Verification is that Certification is used only where DNV's scope covers the integrity of the entire pipeline system and results in the issue of a DNV pipeline certificate

105 Verification is used where DNV's scope applies to the verification of only a single (or more) phase of the project, for example, verification of the design but not of construction, installation or testing. Verification results in the issue of a DNV Statement of Compliance

106 The purpose of the pipeline certificate shall confirm that the pipeline, as installed and ready for use, is in a condition that complies with the technical requirements. These requirements will be agreed by the project and will need to incorporate any regulatory requirements relevant for the location.

107 The primary scope of the certification work is the verification of the integrity of the pipeline, or its capacity to contain the contents under the specified conditions. Other aspects, such as the verification of the environmental impact of the pipeline system, or its fitness for purpose with respect to flow capacity and flow assurance, may be included in DNV's scope of work, if desired by the client.

A 200 Reference codes

201 DNV services with respect to pipelines are described in DNV Publication: DNV-OSS-301 Certification and Verification of Pipelines. While this makes reference to DNV OS F101 Submarine Pipeline Systems as a recognised standard for design and fabrication of offshore pipelines, certification may also be based on other standards issued by internationally recognised bodies, such as API or ISO.

202 DNV has also issued a number of recommended practices which may be used :

DNV-RP-B401	Cathodic Protection Design
DNV-RP-F101	Corroded Pipelines
DNV-RP-F102	Pipeline Field Joint Coating and Field Repair of Linepipe Coating
DNV-RP-F103	Cathodic Protection of Submarine Pipelines by Galvanic Anodes
DNV-RP-F104	Mechanical Pipeline Couplings
DNV-RP-F105	Free Spanning Pipelines
DNV-RP-F106	Factory Applied External Pipeline Coatings for Corrosion Control
DNV-RP-F107	Risk Assessment of Pipeline Protection

A 300 Project phases

301 The process of DNV's certification and verification of pipeline systems is based on distinct project phases and the recognition of key milestones. Verification performed by DNV as part of the certification process, progresses through these project phases and includes all aspects of the project.

302 The certification process follows the project phases:

— *Pre-certification (optional):*

1) Conceptual design

— *Design Review:*

1) Detail design

— *Construction Follow-up:*

1) Manufacturing of linepipe
2) Manufacturing and fabrication of pipeline components and assemblies
3) Manufacturing of corrosion protection and weight coating
4) Installation

— *Project completion*

1) Issue of certificate

— *Maintenance of certificate (optional – may also depend on regulatory requirements):*

1) Operations, maintenance and repair.

SECTION 6
MARINE OPERATIONS

A. Principles of Marine Operations

A 100 General

101 In addition to verification during the design, construction and operations phase, the verification may also cover the phase of marine operations including transit and installation, on agreement with the client.

A 200 Verification services

201 DNV offer independent third party verification services of marine operations, or parts thereof. This verification service may, dependent on agreed scope, involve elements such as independent reviews, analysis, inspection and surveys.

A 300 Approval services / warranty surveys

301 DNV may confirm acceptability of the object under consideration, equipment, planning and preparation by issuance of a Marine Operation Declaration.

302 Compliance will be confirmed by review of:

— Analysis
— Strength Calculations
— Equipment certificates
— Verification Statements
— Plans and procedures
— Test programmes
— Personnel qualifications

303 The DNV service includes attendance at the operations to confirm acceptable conditions for commencement of the operations, performance according to accepted procedures and evaluation and approval of alterations or modifications to these as required.

304 The aspects covered typically range from planning, design, and engineering, to testing, inspections and surveillance.

305 All work performed by DNV is based on the “DNV Rules for Planning and Execution of Marine Operations”

These DNV Rules are structured into three parts:

— Part 0 – includes information and instructions to users, and systematic and alphabetic indexes
— Part 1 – specifies the general operational and technical basis common for all types of marine operations.
— Part 2 – specifies specific guidance and requirements for various types of operations such as load-out, transportation, lifting, offshore installation, sub sea installations, location approvals, etc.

306 The sections from ”DNV Rules for Planning and Execution of Marine Operations” that are most relevant for an offshore gas terminal are as follows:

— Pt.1 Ch.2 Planning of Operations
— Pt.1 Ch.3 Design Loads
— Pt.1 Ch.4 Structural Design
— Pt.2 Ch.2 Towing
— Pt.2 Ch.3 Special Sea Transports

307 Those aspects assessed with respect to marine operations would typically include:

— Structural strength
— Ballast systems and equipment
— Commissioning of ballast system
— Stability
— Minimum bollard pull requirements
— Number and size of tugs required
— Towing arrangement and equipment
— Soil
— Grouting
— Operational procedures
— Weather restrictions

308 For a GBS gas terminal the following aspects would typically be critical:

— Out of dock operation; i.e. winching/towing of the completed GBS or the base structure out of a construction drydock. Special emphasis given to GBS weight and minimum seabed clearances.
— Possible installation of LNG storage tanks in the GBS base
— Towing of GBS from construction site to deck mating site. Special emphasis given to towing route and towing spread/contingencies
— Mooring of the GBS during completion work (and mating) has to endure the environmental loads (wind, current and waves) on the site.
— Mating of GBS and topside. Usually a sensitive operation needing careful planning and evaluation of contingencies and back-up.
— Towing of the completed GBS platform to the installation site. Stability of the platform to be checked in addition to navigation and towing related areas.
— Installation of the platform on the seabed. Special emphasis given to positioning requirements and arrangements, soil behaviour, etc.

309 For a floating gas terminal the following aspects would typically be critical:

— Design and installation of mooring system on field
— Towing of floating terminal from construction site to field
— Hook-up of floating terminal into the field mooring system
— Lifting of Modules

SECTION 7
DOCUMENTATION FOR VERIFICATION

A. General

A 100 Typical documentation and type of service

101 In this chapter typical documentation to be submitted in connection with verification of an LNG terminal is described. The level of detail and areas to be covered will obviously depend on the contractual agreements. It should be noted that for classification of an LNG terminal there will be a minimum set of areas to be documented in order for DNV to issue a classification certificate. The areas described in this chapter are covering more than the minimum requirements in this respect.

102 Depending on type of terminal, parts of or whole groups of documentation described in the following will not be relevant. A detailed list reflecting the type of terminal and operational mode must therefore be established in each case.

B. Structural design

B 100 Type of installation

101 LNG terminals may be either fixed or floating, and the construction material may be steel or concrete or a combination. The documentation requirements will vary depending on construction material and type of terminal.

B 200 Environmental data

201 The environmental data used as basis for the design should be submitted. This should include:

- Waves
- Wind
- Current profile
- Water depths
- Soil conditions
- Marine growth, thickness and specific weight
- Seismic conditions

B 300 Floating terminals

301 For a floating terminal the following documentation will typically be required in connection with verification of the design and construction:

- general arrangement plan
- plans for spaces and tanks
- structural design brief
- design load plan, including design accidental loads
- structural categorisation plan
- shell expansion drawing
- model test documentation
- loading manual
- docking arrangement plan
- fabrication specification, including welding procedures
- design analyses, both global and local design, including temporary phases such as transit
- standard details
- local arrangement plans
- corrosion protection
- opening and closing appliances
- stability, including inclining test procedure, stability manual watertight integrity plans, etc.
- freeboard plan and list of watertight and weather tight items
- description of access for inspection and maintenance of the structure.

B 400 Fixed terminals

401 A fixed terminal can be a gravity based structure, GBS, or a jacket structure. Typical documentation to be submitted for verification of the structural design of a fixed terminal will be:

- general description of the design in terms of size and type of structure, layout of equipment, deck elevations, operational loading requirements and design life and construction material
- general arrangement plan
- description of computer programs used in design
- field data in terms of location and orientation of the terminal
- soil data and foundation analysis
- description of scour protection system
- plans for spaces and tanks
- structural design brief
- design load plan, including design accidental loads
- structural categorisation plan
- loading manual
- docking arrangement plan
- fabrication specification, including welding procedures
- design analyses, both global and local design, including temporary phases such as transit
- standard details
- local arrangement plans
- corrosion protection
- description of access for inspection and maintenance of the structure.

C. Position keeping

C 100 General

101 The position keeping system can be included in the verification of an LNG terminal. Typically it will comprise the anchors/suction piles, anchoring lines, windlasses and winches on board the terminal. The following documentation will typically be submitted:

- line and anchor pattern
- type and weight and dimension of all line segments
- characteristic line strength
- anchor type, size, weight and material specification
- arrangement of fairleads ad anchor points/pretensions
- position and weight of buoyancy elements and weight elements
- position and type of connection elements, such as Kenter shackles, D-shackles, and triplates
- windlass, winch and stopper design
- mooring line tensions in ULS and ALS limit states
- fatigue calculations of mooring line segments and accessories
- strength calculations of anchors, windlass components and fairleads
- corrosion allowance.

102 For terminals with thruster assisted mooring systems, the thruster system and thruster control system should also be documented. In addition an FMEA and test program covering failure situations should be included.

D. LNG handling and containment system

D 100 General

101 The LNG containment system for an LNG terminal will typically be designed according to the requirements in DNV Rules for Ships, Pt.5 Ch.5 Liquefied Gas Carriers, or NFPA 59A or EN 1473 for tanks based on land terminal design. Depending on type of tanks etc. the following documentation will typically be a basis for verification:

— drawing of storage tanks including information on non-destructive testing of welds and strength and tightness testing of tanks
— drawings of support and staying of independent tanks
— drawing of antiflotation arrangement for independent tanks
— specification of materials in storage tanks and product (LNG) piping systems
— specifications of welding procedures for storage tanks
— specification of stress relieving procedures for independent tanks type C (thermal or mechanical)
— specification of design loads and structural analysis of storage tanks
— a complete stress analysis shall be submitted for independent tanks, type B and type C
— detailed analytical calculation of hull and tank system for independent tanks, type B
— specification of cooling-down procedure for storage tanks
— arrangement and specifications of secondary barriers, including method for periodically checking of tightness
— documentation of model tests of primary and secondary barriers of membrane tanks
— drawings and specifications of tank insulation
— drawing of marking plate for independent tanks
— construction and specifications of pressure relief systems for hold spaces, interbarrier spaces and product piping if such systems are required
— calculation of hull steel significant temperature when storage temperature is below -20°C
— Specification of tightness test of hold spaces for membrane tank system
— arrangement and specifications of means for maintaining the storage tank vapour pressure below MARVS – Maximum Allowable Relief Valve Setting (cooling plant, gas burning arrangement, etc.)
— drawings and specifications of protection of hull steel beneath liquid piping where liquid leakage may be anticipated, such as at shore connections and at pump seals
— arrangement and specifications of piping systems for gas freeing and purging of storage tanks
— arrangement of piping for inerting of inter-barrier and hold spaces
— location of gas sampling points within storage tanks
— bilge and drainage arrangements in product pump rooms, product compressor rooms, cofferdams, pipe tunnels, hold spaces and inter-barrier spaces.

102 Furthermore, the following should typically be submitted for the LNG handling system:

— drawings and specifications of product and process piping including vapour piping and vent lines of safety relief valves or similar piping, and relief valves discharging liquid product from the product piping system
— drawings and specifications of offsets, loops, bends and mechanical expansion joints, such as bellows, slip joints (only inside tank) or similar means in the product piping
— drawings of flanges and other fittings in the product piping system unless in accordance with a recognised standard
— drawings of valves in the product piping system, if of a new type or of an unconventional design
— complete stress analysis of piping system when design temperature is below -110°C
— documentation of type tests for expansion components in the product piping system
— specification of materials, welding, post-weld heat treatment and non-destructive testing of product piping
— specification of pressure tests (structural and tightness tests) of product and process piping
— program for functional tests of all piping systems including valves, fittings and associated equipment for handling product (liquid or vapour)
— drawings and specifications of insulation for low temperature piping where such insulation is installed
— specification of electrical bonding of piping
— specification of means for removal of liquid contents from product loading and discharging crossover headers and or product hoses prior to disconnecting the shore connection
— drawings and specifications for safety relief valves and pressure/vacuum relief valves and associated vent piping.

E. LNG processing and regasification system

E 100 General

101 For the LNG processing and regasification system typical documentation to be submitted for review is listed below:

— process system basis of design
— process simulations
— equipment layout or plot plans
— piping and instrument diagrams (P & ID), process flow diagrams (PFD)
— shutdown cause and effect charts
— flare and blowdown system study or report (including relevant calculations for e.g. capacity requirements, back pressure, equipment sizing, depressurising profile, low temperature effects, liquid entrainment etc.)
— sizing calculations for relief valves, bursting discs and restriction orifices
— flare radiation calculations and plots
— philosophy for protection against cryogenic leakage
— cold vent dispersion calculations and plots
— HAZOP study report
— piping and valve material specification for process and utility systems (covering relevant data, e.g. maximum or minimum design temperature or pressure, corrosion allowance materials for all components, ratings, dimensions reference standards, branch schedules etc.).
— line list
— arrangement showing the location of main electrical components
— "one-line wiring diagrams", cable schedules, equipment schedules, power distribution and main cable layout.

102 In addition, interfaces between the processes related systems and other utility and/or marine systems should be documented.

F. Marine and machinery systems

F 100 Floating installations

101 Marine and machinery systems for a floating unit are covered by DNV-OS-D101, Marine and Machinery System. Typical systems are ballast system, bilge system, fuel system, HVAC system, etc. For self propelled units propulsion and steering systems should also be documented. Documentation for such systems should include:

— piping (or ducting) and instrumentation diagrams
— piping specifications
— functional description
— control system

— reliability studies for safety critical systems.

F 200 Fixed installations

201 Typical systems for a fixed unit could be ballast system, (for the installation phase), fuel systems, HVAC systems, etc. Documentation type for the systems should include:

— piping (or ducting) and instrumentation diagrams
— piping specifications
— functional description
— control system
— reliability studies for safety critical systems.

G. Fire protection and safety systems

G 100 General

101 As a general basis for the fire protection and safety systems, a risk analysis should be conducted, where design accidental loads are defined, as well as risk mitigating measures. These loads should cover fire and explosion loads, impact loads from dropped objects and collisions, unintended flooding and loads caused by extreme weather. Based on input from the risk analysis and prescriptive requirements in applicable codes, the following should typically be documented:

— active fire fighting systems, including pumps and distribution system
— fire water demand
— fixed fire fighting systems in specific areas, e.g. water mist system
— passive fire protection
— general arrangement of the terminal
— hazardous area classification
— emergency shutdown system
— escape routes
— evacuation systems and life saving appliances.

H. Electrical systems

H 100 General

101 The verification of the electrical power generation and distribution system on an LNG terminal will be based on the following typical documentation:

— overall single line diagram for main and emergency power
— principal cable routing sketch
— cable selection philosophy
— load balance
— discrimination analysis
— table of Ex-installation
— electrical system calculations
— battery systems.

I. Instrumentation and control systems

I 100 General

101 Typical documentation for instrumentation and control systems is:

— functional description of control systems
— system block diagrams
— power supply arrangements
— user interfaces
— instrumentation and equipment lists
— arrangement and layouts
— description of functions covered by software.

J. Testing and commissioning

J 100 General

101 Typical documentation includes:

— test procedures for quay/dock trials, sea trials, post installation testing (as appropriate).

SECTION 8 REGULATORY COMPLIANCE

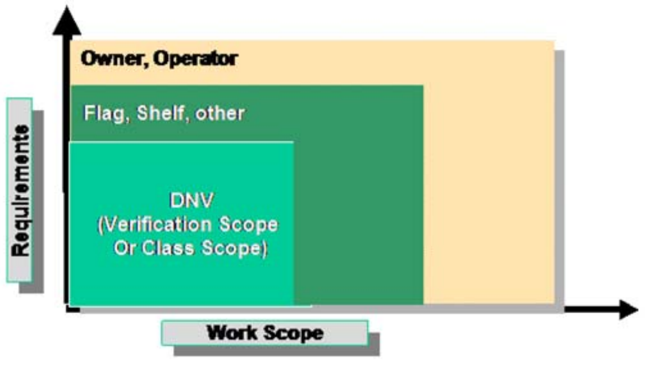
A. Shelf State

A 100 General

101 Offshore terminals will be subject to regulatory requirements from the shelf state within whose jurisdiction the terminal is located. Some authorities will have detailed prescriptive requirements; others may have more functional requirements. Some authorities may play a very active role in verifying compliance, others may delegate to maritime authorities or to 3rd parties to confirm satisfactory compliance. The regulatory regime will therefore be geographically dependent.

102 In all cases however it will be up to the Operator to document compliance with regulatory requirements. Typically the Operator will have in place a verification scheme in order to meet his own project quality, safety and economic requirements. In some cases Operator requirements may well exceed those required by regulatory bodies. DNV verification and Class scope will contribute to meet the overall project verification needs.

103 It is typically the case that regulatory authorities may have requirements in excess of Class, and will have requirements in areas which Class does not usually address (e.g. lifesaving, pollution control). However the DNV Class or verification scope may be extended to include aspects normally covered by regulatory authorities either as part of a delegation from those authorities or as a means for the Operator to confirm compliance with those requirements as part of his submission for regulatory compliance. Similarly the Operator may request DNV to cover verification of additional company requirements.



104 The above figure illustrates the overall project needs for verification, and indicates how DNV can perform a role in assisting the Operator to meet part or most of his verification needs. The DNV scope in a specific project may also extend into areas shown as Flag/Shelf State or Owner/Operator, depending on the specific agreement between the client and DNV.

105 DNV is authorised to carry out verification with respect to regulatory requirements and DNV also plays the important role of liaising with authorities in order to assist the process of regulatory compliance. In any project this will involve typically tripartite meetings with DNV, the Operator and the Regulatory Authority.

106 Currently regulations are being developed as more projects are being actively proposed. DNV works in close cooperation with regulatory authorities to provide input based on our experience.

107 Regulatory compliance will require regular follow up to ensure continued compliance throughout the service life. The extent and nature of the follow up will be determined by the regulatory regime, the Operator's inspection and maintenance philosophy and the agreed scope of the verification agency.

SECTION 9
USE OF RISK ASSESSMENT METHODOLOGY

A. Risk Assessment Complementing Generic, Prescriptive Requirements

A 100 General

101 A number of the verification approaches described earlier are based primarily on prescriptive requirements. However in recognition of the fact that new concepts, such as offshore terminals, represent elements of novel technology, the generic prescriptive requirements are also complemented by recommendations to use risk assessment to identify and mitigate against hazards associated with novel technology and novel application of existing technology.

102 The design of offshore terminals employs known technology to a large extent, i.e.:

— concrete GBS structures
— steel GBS structures
— floating steel structures
— floating concrete structure
— IMO containment tanks
— land-based storage tanks
— liquefaction and regasification systems.

It is the combination of these in an offshore environment that represents the technical challenge, e.g.

— gas treatment and liquefaction on a floating installation
— storage and processing LNG together with having living quarters in proximity
— testing and inspection of large permanently located containment tanks
— cryogenic leakage and drainage on an offshore installation
— offloading between two floating bodies.

103 Whereas prescriptive requirements may exist for the individual technologies, and may be documented in international codes and standards (e.g. API, ISO, NFPA, IMO), the combination of these technologies may not be adequately addressed. This makes selection and application of codes a critical challenge in design and construction of offshore terminals. In order to identify and address the interfaces and gaps in existing standards, risk assessment methodology provides a structured and recognized approach.

104 Risk assessment is the overall process of risk (hazard) identification, risk analysis and risk evaluation. The results of the assessment identify areas of most significant risk and enable risk reduction measures to be targeted where most effective.

105 Risk assessment is intended to provide input to design through systematic consideration of:

— the hazards that can occur
— the role and performance of structure and facilities in preventing and protecting against hazards
— the effects of hazards on safety of personnel and the environment.

106 The risk assessment is intended to be complementary to, and integrated with, the application of recognised design standards. The guidance and requirements of engineering standards will provide the basis for detailed engineering design that can be optimised by the application of, and findings from, the assessment (e.g. establishing optimum dimensioning accidental loads).

107 The assessment should ideally be performed at concept stage and updated as the design evolves through detailed design and construction.

108 Preliminary assessment work should aim to ensure that a safe practicable concept is carried forward to detailed design. Matters to be considered include inherent safety through avoiding unnecessary hazards, reducing hazards, optimising layout etc.

109 A typical assessment process is shown in Figure 1. Some stages may require an iterative process as the concept develops and more details are known.

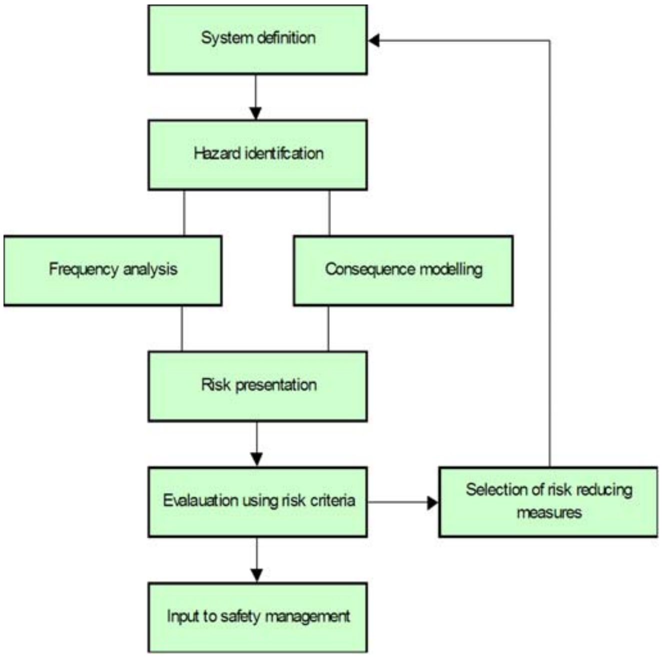


Figure 1
Flowchart for safety assessment

110 The content of the principal tasks is described in the following sections.

A 200 Hazard identification

201 Hazard identification should be by means of formal identification techniques, e.g. HAZOPS, HAZID, FMEA etc., by competent personnel from a suitable variety of engineering disciplines, operational and design backgrounds. The identification should, as a minimum, focus on hazards that could directly, or indirectly, result in:

— loss of life
— major fire or explosion
— cryogenic release
— loss of structural integrity or control
— the need for escape or evacuation
— environmental impact.

202 Although not directly related to safety the Operator will usually also consider economic loss and loss of reputation.

203 A typical, but not necessarily exhaustive, list of hazards for an offshore terminal would be:

— loss of containment
— Escalation of leakage as a result of cryogenic spill
— gas release into confined space
— release of toxic or other hazardous substances

— fire and explosion
— collisions
— helicopter crash
— structural and/or foundation failure
— dropped objects
— stability and buoyancy failure (for floating installations)
— loss of mooring.

A 300 Hazard frequency and consequence reduction

301 Identified hazards should be avoided wherever practicable. This can be achieved by either

— removal of the source of a hazard (without introducing new sources of hazard) or
— breaking the sequence of events leading to realization of a hazard.

302 Where hazards cannot be avoided, design and operation should aim to reduce the risk level by reducing the likelihood of hazards occurring where practicable, for example. by:

— reduction in the number of leak sources (flanges, instruments, valves etc.)
— removal or relocation of ignition sources
— simplifying operations, avoiding complex or illogical procedures and inter-relationships between systems
— selection of other materials
— mechanical integrity or protection
— reducing the probability of external initiating events, e.g. lifting operations etc.
— reduction in inventory, pressure, temperature
— use of less hazardous materials, processes or technology.

303 Since the overall level of risk is a product of the likelihood and the consequence, risk may also be reduced by tackling the consequences. The consequences of hazards should be controlled and mitigated with the aim of reducing risk to personnel where practicable, for example through:

— relocation of equipment, improved layout
— provision of physical barriers, distance separation, fire walls etc.
— provision of detection and protection systems
— provision of means to escape and evacuate.

304 As a general principle measures to reduce the frequency should be preferred to measures to reduce consequence.

A 400 Hazard evaluation

401 Identified hazards and potential escalation need to be evaluated based on their effects, consequences and likelihood of occurrence. This evaluation should address the sources and contributors in the chain of events leading to a hazard, including the effect of any prevention and protection measures.

402 The evaluation may be by means of qualitative and/or quantitative analysis as necessary to provide input for comparison with safety targets and safety criteria.

403 Where used, models and data should be appropriate, and from industry recognized sources.

404 Hazards that are commonly considered as not reasonably foreseeable, i.e. extremely unlikely to occur, may be discounted from the evaluation provided that this is clearly indicated and justified in the assessment.

A 500 Dimensioning accidental loads

501 The risk assessment will identify a number of residual risks which must be accounted for in the design. The design needs to be dimensioned for the anticipated loading from these accidental events.

502 The dimensioning accidental loads for an offshore terminal structure and important safety systems on the terminal shall be identified and included in the evaluation. These are expected to include accidental loads such as:

— toxic or flammable fluids (e.g. smoke hydrocarbon gas, etc.)
— cryogenic release
— fire
— explosion
— flooding and stability
— collision and impacts
— environmental effects

and their effect on systems or facilities such as:

— fire and gas detection
— ESD, PSD, and other shutdown systems
— containment system instrumentation
— flare and depressurising system (blowdown/venting)
— fire and explosion protection
— active fire protection systems
— impact protection
— alarm, internal, and external communications
— emergency power systems and UPS
— arrangements for escape and evacuation
— life support at temporary refuge and muster facilities
— structure
— mooring or positioning system
— stability systems.

503 Having identified the design accidental loads, their effects may be assessed by reference to DNV-RP-C204 Design against Accidental Loads (draft).

A 600 Safety criteria

601 The final selection of dimensioning accidental loads needs to be suitable for the installation to meet the defined safety criteria. Table A1 shows typical safety targets. Where the safety criteria are exceeded, the initial dimensioning loads may need to be revised.

Table A1 Typical safety targets

No.	*Safety target*
1.	An escape route shall be available from every work area for sufficient time for personnel to reach the temporary refuge or evacuation facilities.
2.	The temporary refuge shall be capable of providing life support and communications for sufficient time to enable controlled evacuation from the unit or installation.
3.	Evacuation and escape facilities shall be available and reliable for use.
4.	Simultaneous loss of all safety targets shall not occur during the time required to: mitigate an accidental event, or leave the unit or installation.

A 700 Documentation of safety level

701 By following the risk-based approach described above and incorporating specific regulatory requirements, a project should be able to provide a structured and documental confirmation that the project has achieved the intended level of safety and has met the defined regulatory requirements.

SECTION 10
QUALIFICATION OF NEW TECHNOLOGY

A. Novel Designs

A 100 General

101 Design of novel gas development projects may typically identify a number of critical subsystems for which there is no relevant service history. For offshore terminals this might include technology such as LNG transfer systems, some cryogenic components or compact liquefaction systems. For CNG systems this could include gas loading and offloading processes in the containment system. These systems may not be adequately described by existing codes or standards.

102 A qualification procedure shall provide a systematic approach to the qualification of new technology, ensuring that the technology functions reliably within specified limits. The approach developed by DNV and described in this section provides a rational qualification philosophy and, by focusing on a balanced use of reliability, ensures a cost effective implementation of technology and an increase in the level of confidence. Sensible input may then be provided to the overall risk assessment of the concept.

103 Qualification of technology benefits all the major players:

— the manufacturer, who offers the new technology to the market and therefore needs to display a proof of fitness for purpose
— the company, who integrates the new technology into a larger system, and needs to evaluate the effect on the total system reliability
— the end-user of the new technology, which must optimize the benefits of his investment through selection between competing technologies and must obtain regulatory compliance for a project incorporating the new technology.

104 The main features of a qualification approach are described below.

A 200 Basis for the qualification

201 The qualification must be based on specified performance limits, boundary conditions and interfacing requirements defined in the qualification basis.

A 300 Qualification process

301 A risk-based approach should be used to obtain the reliability goals in the qualification. These goals should be specified in the qualification basis. The procedure will specify the philosophies, principles and methods to be used in the qualification process. At each step of the process there is a need for documentation making the process traceable.

302 The qualification process should comprise the following main activities:

— establish an overall plan for the qualification. This should be a continuous process and needs updating after each step using the available knowledge on the status of the qualification.
— establish a qualification basis comprising: requirements, specification and description. Define the functionality and limiting parameters for the new technology.
— screening the technology based on identification of failure modes and their risk, and classification of the technology in degree of novelty to focus the effort where the related uncertainty is most significant.
— assess maintenance, condition monitoring and possible modification effects to reduce the risk.
— plan and execute reliability data collection. The data is used to analyze the risk of not meeting the specifications through: experience, numerical analysis and tests.
— analyze the reliability of the new technology, and thereby the risk of the failure modes related to the functional requirements of the new technology.

303 These logical steps in the qualification process are combined and visualized in groups in Figure 1. The results from one step are the input to the next step.

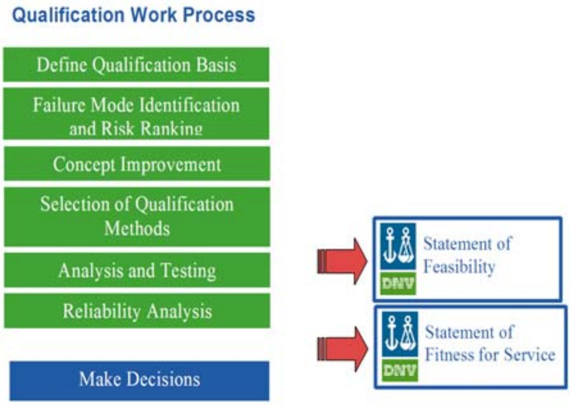


Figure 1
Main qualification activities

304 There will be feedback loops between the steps so that results that lie outside the specified limits can lead to a design modification, specification modification or maintenance plan modification.

A 400 Establishment of reliability

401 The qualification process can be run throughout the development of the new technology, or be started at any time in the development. Figure 2 illustrates that the failure probability at the service life target is reduced through the qualification work until an acceptable failure probability is achieved.

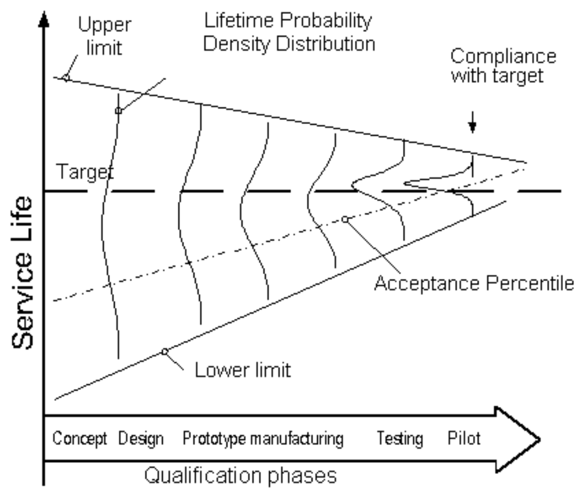


Figure 2
Illustration of the qualification process.

402 Qualification is considered completed when the acceptance percentile crosses the target level for the service life.

403 A qualitative approach can be practical to use in the early development phase (conceptual phase). Quantitative measures are more relevant in the later development phase.

A 500 Testing

501 The analytical approach is supported and complemented by results obtained from testing. Tests as described below are used for materials, components, sub-assemblies and assemblies. The typical tests are termed:

— basic tests, such as testing of material properties
— prototype tests (qualification tests); of components, sub-assemblies and assemblies verify the functional requirements of a new type design. Prototype test can be carried out in phases including laboratory tests, and various degrees of environmental and full service tests (e.g. shallow and deep water, hydrocarbon service).
— factory acceptance tests (FAT), of sub-assemblies and assemblies verify the manufacturing and assembly of a system, which is already prototype tested.
— pre and post installation tests, of the full assembly verify the soundness prior to and after the completed installation.
— pilot application, represent the first use and is therefore normally regarded as an advanced test to gain more experience with the system, ensuring that all aspects of a complex system has been taken into account.

A 600 End product of the qualification

601 The result of the qualification should be documentation of fitness of purpose and should cover:

— the lifetime probability density distribution

and/or

— defined margins against specified failure modes.

A 700 Use of the results

701 The qualification results may be used for a number of different purposes:

— as an acceptance for implementation of new technology
— for comparison between alternative technologies
— as input in the evaluation of the reliability of a larger system of which the qualified new technology may be a part
— as part of the concept final risk assessment
— in documenting regulatory compliance.

A 800 Reference

801 For more detailed information on the procedure, reference should be made to DNV-RP-A203 “Qualification Procedures for New Technology”.