



Index on Applicable Risk Analysis for Marine and Offshore

December 2017

**Guidance Note
NI 635 DT R00 E**

Marine & Offshore
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VERITAS**

MARINE & OFFSHORE - GENERAL CONDITIONS

1. INDEPENDENCY OF THE SOCIETY AND APPLICABLE TERMS

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

2. DEFINITIONS

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

3. SCOPE AND PERFORMANCE

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

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

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

The Society will not:

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

4. RESERVATION CLAUSE

- 4.1. The Client shall always: (i) maintain the Unit in good condition after surveys; (ii) present the Unit after surveys; (iii) present the Unit for surveys; and (iv) inform the Society in due course of any circumstances that may affect the given appraisal of the Unit or cause to modify the scope of the Services.
- 4.2. Certificates referring to the Society's Rules are only valid if issued by the Society.
- 4.3. The Society has entire control over the Certificates issued and may at any time withdraw a Certificate at its entire discretion including, but not limited to, in the following situations: where the Client fails to comply in due time with instructions of the Society or where the Client fails to pay in accordance with clause 6.2 hereunder.

5. ACCESS AND SAFETY

- 5.1. The Client shall give to the Society all access and information necessary for the efficient performance of the requested Services. The Client shall be the sole responsible for the conditions of presentation of the Unit for tests, trials and surveys and the conditions under which tests and trials are carried out. Any information, drawings, etc. required for the performance of the Services must be made available in due time.
- 5.2. The Client shall notify the Society of any relevant safety issue and shall take all necessary safety-related measures to ensure a safe work environment for the Society or any of its officers, employees, servants, agents or subcontractors and shall comply with all applicable safety regulations.

6. PAYMENT OF INVOICES

- 6.1. The provision of the Services by the Society, whether complete or not, involve, for the part carried out, the payment of fees thirty (30) days upon issuance of the invoice.
- 6.2. Without prejudice to any other rights hereunder, in case of Client's payment default, the Society shall be entitled to charge, in addition to the amount not properly paid, interests equal to twelve (12) months LIBOR plus two (2) per cent as of due date calculated on the number of days such payment is delinquent. The Society shall also have the right to withhold certificates and other documents and/or to suspend or revoke the validity of certificates.
- 6.3. In case of dispute on the invoice amount, the undisputed portion of the invoice shall be paid and an explanation on the dispute shall accompany payment so that action can be taken to solve the dispute.

7. LIABILITY

- 7.1. The Society bears no liability for consequential loss. For the purpose of this clause consequential loss shall include, without limitation:
 - Indirect or consequential loss;
 - Any loss and/or deferral of production, loss of product, loss of use, loss of bargain, loss of revenue, loss of profit or anticipated profit, loss of business and business interruption, in each case whether direct or indirect.

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

- 7.2. In any case, the Society's maximum liability towards the Client is limited to one hundred and fifty per-cents (150%) of the price paid by the Client to the Society for the performance of the Services. This limit applies regardless of fault by the Society, including breach of contract, breach of warranty, tort, strict liability, breach of statute.
- 7.3. All claims shall be presented to the Society in writing within three (3) months of the Services' performance or (if later) the date when the events which are relied on were first discovered by the Client. Any claim not so presented as defined above shall be deemed waived and absolutely time barred.

8. INDEMNITY CLAUSE

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

9. TERMINATION

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

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

10. FORCE MAJEURE

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

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

11. CONFIDENTIALITY

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

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

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

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

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

12. INTELLECTUAL PROPERTY

- 12.1. Each Party exclusively owns all rights to its Intellectual Property created before or after the commencement date of the Conditions and whether or not associated with any contract between the Parties.
- 12.2. The Intellectual Property developed for the performance of the Services including, but not limited to drawings, calculations, and reports shall remain exclusive property of the Society.

13. ASSIGNMENT

- 13.1. The contract resulting from these Conditions cannot be assigned or transferred by any means by a Party to a third party without the prior written consent of the other Party.
- 13.2. The Society shall however have the right to assign or transfer by any means the said contract to a subsidiary of the Bureau Veritas Group.

14. SEVERABILITY

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

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

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

15. GOVERNING LAW AND DISPUTE RESOLUTION

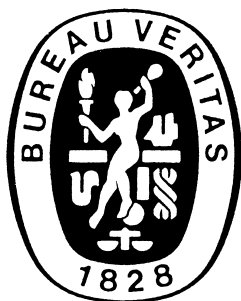
15.1. The Conditions shall be construed and governed by the laws of England and Wales.

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

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

16. PROFESSIONAL ETHICS

- 16.1. Each Party shall conduct all activities in compliance with all laws, statutes, rules, and regulations applicable to such Party including but not limited to: child labour, forced labour, collective bargaining, discrimination, abuse, working hours and minimum wages, anti-bribery, anti-corruption. Each of the Parties warrants that neither it, nor its affiliates, has made or will make, with respect to the matters provided for hereunder, any offer, payment, gift or authorization of the payment of any money directly or indirectly, to or for the use or benefit of any official or employee of the government, political party, official, or candidate.
- 16.2. In addition, the Client shall act consistently with the Society's Code of Ethics of Bureau Veritas, <http://www.bureauveritas.com/home/about-us/ethics-and-compliance>



GUIDANCE NOTE NI 635

Index on Applicable Risk Analysis for Marine and Offshore

SECTION 1	GENERAL
SECTION 2	RISK ANALYSIS IN THE SOCIETY'S RULES
SECTION 3	RISK ANALYSIS IN IMO RULES
SECTION 4	RISK ANALYSIS IN INDUSTRY
SECTION 5	RISK ANALYSIS FOR INLAND NAVIGATION VESSELS
SECTION 6	INDEX

Section 1 General

1	General	5
1.1	Purpose	
1.2	Application	
1.3	Notice	
2	Definitions	6
2.1	Hazard	
2.2	Risk	
2.3	Risk analysis	
2.4	Risk assessment	
2.5	Acronyms	
3	Type of analysis	6
3.1	Hazard Assessment	
3.2	Risk analysis	
3.3	Consequence analysis	
3.4	Reliability and integrity	
3.5	Risk quantification/reduction	

Section 2 Risk Analysis in the Society's Rules

1	General	10
1.1	General	
2	Service notations and additional service features	10
2.1	Risk analysis for the type or service - Service notation and additional service features	
3	Additional equipment or specific arrangement - Additional class notation	10
3.1	Risk analysis for additional class notation	
4	Naval ships	10
4.1	Risk analysis for naval ships	

Section 3 Risk Analysis in IMO Rules

1	General	35
1.1	General	
2	SOLAS	35
2.1	Risk analysis as required by SOLAS	
3	IGC code	35
3.1	Risk analysis as required by IGC	
4	IGF code	35
4.1	Risk analysis as required by IGF code	

5	High speed craft - HSC 2000	35
5.1	Risk analysis as required by HSC 2000 code	
6	Polar code	35
6.1	Risk analysis as required by Polar code guidance	
7	Alternative design	40
7.1	General	
8	Formal Safety Assessment (FSA)	40
8.1	General	

Section 4 Risk Analysis in Industry

1	General	41
1.1	General	
2	Ship to ship transfer guide	41
2.1	Risk analysis as required by Ship to ship transfer guide	
3	TMSA2	41
3.1	Risk analysis as required by TMSA2	

Section 5 Risk Analysis for Inland Navigation Vessels

1	General	43
1.1	General	

Section 6 Index

1	Reference documents	45
2	Index	46

SECTION 1

GENERAL

1 General

1.1 Purpose

1.1.1 The present Note is an index of the risk analysis to help Owners & designers identify in advance the studies and risk analysis which are required or recommended in the Marine & Offshore main Rules & Regulations (BV Rules and Notes, IMO regulations, Industry best practice).

1.2 Application

1.2.1 This Guidance Note is intended to cover wide range of floating units, as detailed hereafter:

- sea-going merchant ships
- renewable energy units:
Current & Tidal Turbines, Floating Offshore Wind Turbine...
- offshore units and installations
- naval ships
- inland navigation vessels.

This Guidance Note only references the documents for which risk analysis are required or recommended. These reference documents remain the reference and the detailed requirements about risk analysis are those indicated in the text themselves.

1.3 Notice

1.3.1 This document summarizes in tables the various types of risk analysis and their required status. The tables are divided for easy reference by the source of referenced documents:

- BV Rules, as detailed in Sec 2
- IMO regulations, as detailed in Sec 3:
 - SOLAS convention
 - IGC code
 - IGF code
 - HSC code 2000
 - Polar code
- Industry good practices, as detailed in Sec 4:
 - Ship to ship transfer guide
 - Tanker Management and Self-Assessment (TMSA2)
- Inland navigation vessel, as detailed in Sec 5.

The required statuses are the followings:

- Recommended:
the risk analysis are optional but highly recommended
- Mandatory
- Mandatory if:
the risk analysis is mandatory under specific condition (specified in the description)
- If requirement adapted:
the risk analysis is required in case of deviation from the original requirement
- BV satisfaction:
the risk analysis may be required at the Society satisfaction
- Administration satisfaction:
the risk analysis may be required at the Administration satisfaction
- For type approval:
the risk analysis is required under the scope of product type approval
- Guidance:
the risk analysis is not required, only guidance is given.

1.3.2 Description of tables

Risk analysis are listed in tables where rows correspond to risk analysis inputs and the columns correspond to categories of information:

- First column indicates the subject considered for the application of the risk analysis.
The subject can be the classification notations, ship type, domain,...
- Second column indicates the type of risk analysis which are recommended, as defined in Article [2].
- Third column indicates the requirement levels of the risk analysis, as defined in [1.3.1].
- Fourth column gives details on risk analysis.
- Last column gives the references to the considered document where the risk analysis is mentioned.

Tables only refers to the documents for which risk analysis are required or recommended. Requirements about risk analysis are those indicated in the referenced documents themselves.

2 Definitions

2.1 Hazard

2.1.1 Hazard means any source of potential damage or casualty, or any situation with potential to cause it.

2.2 Risk

2.2.1 Risk is a concept quantifying a hazard, consisting in a combination of probability or frequency and consequence of the related hazard.

2.3 Risk analysis

2.3.1 Risk analysis is a structured method involving:

- identification of hazards related to the unit, installation or equipment
- estimation of hazard probabilities or frequencies
- estimation of hazard consequences.

2.4 Risk assessment

2.4.1 Risk assessment is a systematic analysis of risks including risk analysis, review of risk acceptability by comparison with agreed criteria and identification of risk reduction measures, when relevant.

2.5 Acronyms

2.5.1

CSRA	: Cryogenic Spill Risk Analysis
DORA	: Dropped Object Risk Assessment
EERA	: Escape, Evacuation and Rescue Analysis
ERA	: Explosion Risk Analysis
ESSA	: Emergency System Survivability Analysis
ETA	: Event Tree Analysis
FMEA	: Failure Modes and Effects Analysis
FMECA	: Failure Modes, Effects and Criticality Analysis
FRA	: Fire Risk Analysis
FSA	: Formal Safety Assessments
FTA	: Fault Tree Analysis
GDA	: Gas Dispersion Analysis
HAZID	: Hazard Identification
HAZOP	: Hazard and Operability Study
LFD	: Large Fire Door
LSA	: Life Saving Appliance
MVZ	: Main Vertical Zone
QRA	: Quantitative Risk Assessment
RA	: Risk Assessment
RAM	: Reliability, Availability and Maintainability
RCM	: Reliability Centered Maintenance
SCRA	: Ship Collision Risk Analysis
SGDA	: Smoke and Gas Dispersion Analysis
SIL	: Safety Integrity Level allocation and verification.

3 Type of analysis

3.1 Hazard Assessment

3.1.1 HAZID - Hazard Identification

The HAZard IDentification (HAZID) is a structured method for identifying hazards, threats and consequences associated with a process, operation or area. It consists of a brainstorming workshop with designer and client personnel engineering disciplines about project management, commissioning and operations.

The major findings and hazard risk ratings help to deliver HSE compliance, and form part of the project Risk Register required by many licensing authorities and company in-house standards

3.1.2 HAZOP - Hazard and Operability Study

A HAZard and OPERability (HAZOP) study, also known as process hazard analysis (PHA), is a well-proven, structured, team-based method for process hazard identification commonly used during the process design phase or for proposed modifications. HAZOP makes detailed examination of the process and engineering intention of new or existing facilities to assess the potential hazards from operating outside of the intended design, or malfunction of individual items of equipment and their consequential effects on the facility as a whole. HAZOP is led by an experienced facilitator.

For an oil & gas project, a core team would typically include personnel from Process, Instrumentation, Machines, Project Engineering, and Operations, and it might require the involvement of process technologists, environmental specialists and corporate Health & Safety and Environment (HSE) staff for some parts of the work

3.1.3 FMEA - Failure Mode and Effects Analysis

A practical, realistic and documented assessment of the failure characteristics of the ship and its component systems should be undertaken with the aim of defining and studying the important failure conditions that may exist.

The FMEA is based on a single failure concept under which each considered system at various levels of a system's functional hierarchy is assumed to fail by one probable cause at a time. The effects of the postulated failure are analysed and classified according to their severity. Such effects may include secondary failures (or multiple failures) at other level(s). Any failure mode which may cause a catastrophic effect should be guarded against by system or equipment redundancy unless the probability of such failure is extremely improbable. For failure modes causing hazardous effects corrective measures may be accepted in lieu. A test program should be drawn up to confirm the conclusions of FMEA.

3.1.4 What-if

The What-if method uses loosely structured questioning to postulate potential upsets that may result in mishaps or system performance problems and ensure that appropriate safeguards against those problems are in place.

3.2 Risk analysis

3.2.1 FTA - Fault Tree Analysis

The Fault Tree Analysis, FTA, is a logic diagram showing the causal relationship between events which singly or in combination occur to cause the occurrence of a higher level event.

3.2.2 ETA - Event Tree Analysis

The event tree analysis (ETA) is an analysis to identify and evaluate the sequence of event in scenarios following the occurrence of an initiating event.

3.2.3 DORA - Dropped Object Risk Assessment

The dropped object study is an analysis to find out what happens to the facility and personnel safety if items are dropped. If the lost object results in an accident or event, structures must be sufficiently protected to absorb the impact energy. The analysis aims at answering the following typical questions:

- which types of lifts should be taken into account, (e.g. maintenance or operations)
- how many lifting points are there and what are the potential dropped object zones/crane arcs/laydown areas
- what types of lifts could result in damage to subsea equipment
- what types of dropped objects need to be assessed.

3.2.4 SCRA - Ship Collision Risk Analysis

For a fixed or permanently moored marine asset, such as a platform, the Ship Collision Analysis involves understanding the level of shipping traffic and the effects resulting from a collision.

The first step of the Risk analysis is a thorough study of the shipping traffic around the asset: the traffic data can be in the form of AIS data or data from Port Authorities.

The second step identifies and selects the likely collision scenarios.

Then an assessment of the probability of collision detailed by type of vessel is carried out based on world recognised casualty databases. The probabilities are then corrected to take into account local parameters (e.g. traffic, environment, pilot assistance).

The consequences of the collision (e.g. structural damage, damage to environment and possible loss of life) are then assessed through various methods using casualty database analysis, qualitative structural assessments, semi-empirical methods, simplified numerical calculations or finite element calculations.

The outcome of the analysis is an evaluation of the risk of collision against the risk acceptance criteria. For a moving asset, say a fleet of LNG/Oil carriers navigating through confined channels, the Ship Collision Analysis involves a study of the navigated channels, the expected traffic and a Risk Analysis of the main risks such as collision, allision, grounding, foundering, fire/explosion and mechanical failure. This study is often used to provide an insight into the risk to the onboard cargo (e.g. oil and LNG) with regards to local environment and people, in the scope of construction of new O&G infrastructures.

3.3 Consequence analysis

3.3.1 FRA - Fire Risk Analysis and ERA - Explosion Risk Analysis

The objectives of the Fire and Explosion Risk Analysis (FERA) are:

- to identify the fire and explosion scenarios resulting from process and non-process failure scenarios
- to evaluate the intensity of effects for these scenarios (i.e. Flame length, Pool size, Heat flux, Gas cloud extent, Overpressure contours)
- to identify the targets vulnerable to the fire and explosion scenarios and evaluate their response to such events
- to identify the escalation potential of each accidental event and the possible damages to the asset, and
- to identify the possible requirement for additional risk reduction measures to help prevent and/or mitigate the effects of the identified fire and explosion scenarios.

3.3.2 GDA - Gas Dispersion Analysis

Gas Dispersion Analysis (GDA) uses a Vent Dispersion Study. The objectives are:

- to model the dispersion of flammable/toxic vapour from the top of the vent mast using appropriate modeling tools, considering all relevant release scenarios
- to evaluate the thermal effects on personnel and structure in case of ignition of the released gas cloud, and
- to check the potential for hazardous exposure of personnel and evaluate impact on the facility.

3.3.3 SGDA - Smoke and Gas Dispersion Analysis

Smoke and gas releases (toxic or flammable) present major hazards to personnel, environment, assets and the business of the operator. To properly control these hazards, companies must anticipate the consequences of such events and develop appropriate and cost-effective measures in terms of plant lay-out, safety design and additional safeguard implementation.

The objectives of the Smoke and Gas Dispersion Analysis (SGDA) are:

- to identify the release scenarios resulting from process and non-process failure events
- to evaluate the intensity of effects for these scenarios (i.e. distance to LC1%, Gas cloud extent)
- to identify the targets vulnerable to the toxic exposure and evaluate their response to such events
- to identify the possible requirement for additional risk reduction measures to help prevent and/or mitigate the effects of the identified dispersion scenarios.

3.3.4 EERA - Escape, Evacuation and Rescue Analysis

The Escape, Evacuation and Rescue Analysis (EERA) encompass all escape, evacuation and rescue items provided on the unit, including the temporary refuges, the muster stations, the escape and evacuation routes, the different evacuation and rescue means (e.g. helicopter, life boats, life rafts) and survival equipment.

Outputs from a Fire and Explosion Risk Analyses (FERA), Smoke and Gas Dispersion Analysis (SGDA) and recommended practices along with understanding of personnel distribution are commonly used to develop escape, evacuation and rescue scenarios in order to:

- evaluate the adequacy of the escape, evacuation and rescue means under identified emergency scenarios (i.e, effects of thermal radiation, blast and smoke/toxic gas)
- assess the adequacy of the evacuation philosophy in terms of primary, secondary and tertiary means of evacuation and circumstances in which different evacuation routes take precedence
- assess the integrity and endurance time of temporary refuges, and
- assess the escape from the individual areas of the installation (i.e. process area decks, accommodation, hull and utility rooms).

3.3.5 ESSA - Emergency System Survivability Analysis

An Emergency Systems Survivability Analysis (ESSA) is carried out to assess the ability of emergency systems to withstand accident conditions such as fire, smoke, blast and hazardous gas releases. It is vital to ensure that these systems perform their function during Major Accident Events.

3.4 Reliability and integrity

3.4.1 FMECA - Failure Mode, Effects and Criticality Analysis

A Failure Mode, Effects and Criticality Analysis (FMECA) study considers each mode of failure for every component of a system, and determines local effects and end effects on system operation, on personnel safety and environment protection. Failure modes are classified in relation to likelihood of the failure occurring and severity of failure effects. Likelihood in combination with severity will generate a criticality rating for each failure mode, which is based upon a predetermined risk matrix.

Starting from the basic failure characteristics of elements and functional structure of the system, FMECA systematically documents the ways equipment can fail, the possible causes, the effects these failures can produce on system performance and ranks each potential failure according to the combination of its severity, its probability of occurrence and the possibility that it can be detected.

These three parameters are qualitatively evaluated referring to defined levels. Five levels for probability, consequences and non-detection are defined. The combination of these three figures (probability, consequences, and non-detection) provides the criticality score associated to the considered failure mode.

The FMECA is carried out on a series of worksheets, where the results are listed in a tabular format, equipment item (or function) by equipment item (or function), following a systematic bottom up approach starting from the lowest level of component failure and rising through the next level of system hierarchy up to the overall system level.

3.4.2 SIL - Safety Integrity Level allocation and verification

Assessing the safety, availability and reliability of Safety Instrumented Systems (SIS).

3.4.3 RAM - Reliability, Availability and Maintainability

Reliability, Availability and Maintainability study (RAM) is a simulation of the configuration, operation, failure, repair and maintenance of equipment. It includes the physical components, equipment configuration and maintenance philosophy in a system. It generates sufficient data needed in order to make decisions for possible systems changes that may increase system efficiency, and therefore increase project profits.

RAM modeling can simulate the configuration, operation, failure, repair and maintenance of equipment. The inputs to RAM modeling will include the physical components, equipment configuration and maintenance philosophy in a system and the outputs can determine average production of the system over the facility or vessel life. RAM studies will generate sufficient data on which to base decisions for possible systems changes that may increase system efficiency, and therefore increase project profits.

3.4.4 RCM - Reliability Centered Maintenance

Reliability Centered Maintenance study (RCM) is a logical, systematic decision making process for defining optimum maintenance tasks (part of Asset Integrity Management Systems, AIMS):

- to focus the preventive maintenance effort on equipment essential to health, safety, environment and/or operation
- to implement an optimized maintenance plan (what, when, how), oriented as far as possible on Condition-Based-Maintenance
- increase inherent reliability and availability of the unit/system in its operating context Validate the adequacy between the installation design, the operation and preventive maintenance
- demonstrate a commitment to improve the reliability, safety and environmental integrity in front of insurers, charterers, regulatory bodies...

3.5 Risk quantification/reduction

3.5.1 RA - Risk Assessment

Generally, the risk assessment study has the following objectives:

- evaluation of the design, taking into account the operational procedures
- determination of limiting conditions of operations (e.g. loading/offloading)
- assessment of safety and operability through risk assessment techniques (e.g. for transfer system).

Risk assessment methodology may be based on the provisions of EN 1474-3 or other recognized standards, such as EN ISO 17776 "Guidelines on tools and techniques for hazard identification and risk assessment".

3.5.2 QRA - Quantitative Risk Assessment

Quantified Risk Assessment (QRA) is a structured approach to identifying and understanding the risks associated with hazardous activities.

The assessment starts by taking inventory of potential hazards, their likelihood, and consequences, including:

- review of safety documents (firefighting and safety layout drawings, fire and gas detection studies, escape, evacuation and rescue analysis and design stage studies, etc.)
- process hazard analysis
- scenario development
- likelihood/frequency analysis

- consequence analysis (such as fire and explosion modeling)
- impact assessment
- risk assessment (comparison against defined criteria)
- recommendations for risk reduction measures
- reporting and documentation.

QRA provides valuable insights into the features of the industrial plant, highlighting those aspects where failures may result in harm to operators, members of the public, the environment and or the asset itself. QRA provides a basis for decision-making in the design and operation of the plant, and may also be required to legally show "fitness to operate".

SECTION 2

RISK ANALYSIS IN THE SOCIETY’S RULES

1 General

1.1 General

1.1.1 The risk analyses in BV Rules and Notes are regrouped for easy reference into the following categories:

- General:
risk analysis for general case, non-associated to a specific classification notation, see Tab 1.
- Service and type notation:
risk analysis in relation with a structural type notation, service notation or additional service features (according to NR467, Pt A, Ch 1, Sec 2, [4] and NR445, Pt A, Ch 1, Sec 2, [4] and NR445, Pt A, Ch 1, Sec 2, [7]), see Tab 2.
- Additional equipment or specific arrangement - Additional class notation:
risk analysis in relation with an additional class notation, (according to NR467, Pt A, Ch 1, Sec 2, [6] and NR445, Pt A, Ch 1, Sec 2, [6]), see Tab 3.
- Naval Ships:
risk analysis for naval ships, see Tab 4.

2 Service notations and additional service features

2.1 Risk analysis for the type or service - Service notation and additional service features

2.1.1 Risk analysis for service notation and additional service features are listed in Tab 2.

3 Additional equipment or specific arrangement - Additional class notation

3.1 Risk analysis for additional class notation

3.1.1 Risk analysis for additional class notation are listed in Tab 3.

4 Naval ships

4.1 Risk analysis for naval ships

4.1.1 Risk analysis for naval ships are listed in Tab 4.

Table 1 : Risk analysis for general application

Risk analysis for general application				
Application	Type	Required status	Descriptions	References
Marine Renewable Energy (MRE)				
Current or Tidal Turbine	HAZID	Mandatory if	Loads If relevant, risk analysis is to be performed considering collision with vessels	NI 603, Ch 1, Sec 3
	HAZID, FMECA	BV satisfaction	Loads For accidental scenarios, a risk analysis may be required to: determine applicable loads and the probabilities of occurrence of various events considered through accidental scenarios.	NI 603, Ch 1, Sec 3
		Mandatory	Certificate Risk assessment for prototype, type and project certificate is to: - identify hazardous situations (collision or climatic extremes). HAZID is recommended - identify components failures. FMECA is recommended.	NI 603, Ch 1, Sec 2
MRE technologies	HAZID, FMEA	Recommended	Prototype certificate Risk assessment for prototype certificate is to: - identify hazardous situations (collision or climatic extremes). HAZID is recommended - identify components failures. FMECA is recommended.	NI 631, Sec 3
			Type certificate Risk assessment for type certificate is to: - identify hazardous situations (collision or climatic extremes). HAZID is recommended - identify components failures. FMECA is recommended.	NI 631, Sec 4
			Project certificate Risk assessment for project certificate is to: - identify hazardous situations (collision or climatic extremes). HAZID is recommended - identify components failures. FMECA is recommended.	NI 631, Sec 5

Risk analysis for general application				
Application	Type	Required status	Descriptions	References
Offshore units				
Conversion of ship	FMEA	Mandatory	Systems FMEA is to be submitted covering machinery, electrical and safety systems.	NI 593, Sec 1
		Mandatory if	Machinery spaces automation Whenever machinery spaces previously designed for manned operations are intended to be modified in view of operations in an unmanned mode, the automation is to be compatible with the equipment and an FMEA is to be submitted for approval, on a case-by-case basis.	NI 593, Sec 4
	HAZID, HAZOP, FRA, ERA, EERA, ESSA, QRA	BV satisfaction	Arrangement and systems If deemed necessary by the Society, a risk analysis is to be performed to validate the arrangement and to determine the accidental loads that the equipment and the systems are capable to withstand.	NI 593, Sec 4
Offshore units and installations	Fault tree	For type approval	Computer based system Risk analysis considering the computer based system ensuring safety function and which are not backed-up by non-computer-based devices, is to: demonstrate the availability and reliability of the computer based system.	NR 445, Pt C, Ch 3, Sec 3
		For Type Approval	Automation system For type approval of systems category III, FMEA is to: demonstrate the reliability of the automation system, including the computer based system. In accordance with IEC 60812.	NR 445, Pt C, Ch 3, Sec 1
	FMEA		Dual fuel engine FMEA is to be submitted, examining: possible faults affecting the combustion process.	NR 445, Pt C, Ch 1, App
			Diesel engine electronic control FMEA is to be submitted and is to: - demonstrate that failure of an electronic control system will not result in the loss of essential services for the operation of the engine and that operation or the engine will not be lost or degraded beyond an acceptable performance criteria or the engine - help to select cases for integration test of electronically controlled diesel engine.	NR 445, Pt C, Ch 1, Sec 2
		Mandatory	Exhaust gas treatment system Risk analysis is to: - substantiate the availability of the machinery served by the exhaust gas treatment systems - demonstrate that in case of failure of such equipment, propulsion power and auxiliary power supplying essential functions are not affected (where necessary, a bypass is to be installed), and that in case of black out, automatic starting of engines, if provided, remains effective.	NR 445, Pt C, Ch 1, Sec 7

Risk analysis for general application				
Application	Type	Required status	Descriptions	References
Offshore units and installations	FMECA	Recommended	General Risk Based Qualification of New technology Methodology Guidelines. Reference to IEC 60812.	NI 525, Sec 1
	FRA	Mandatory	Plastic piping For plastic pipe, the Fire Risk Analysis Study and Report complies with: level of fire endurance of plastic pipes on hull deck of offshore units.	NR 445, Pt C, Ch 1, App 2
	HAZID	Mandatory	Exhaust gas treatment system When use of substances mentioned in IMDG code: - ventilation necessity (treatment products tanks) is considered with relevant risk analysis - common ventilation (compartment where treatment products are stored or used with other compartments) may be accepted based on risk analysis - specific risk analysis is to be submitted in case of substance covered by IEC 60092-502 or -506 are used - risk analysis is to be provided to evaluate the occurrence and level of danger for crew and passengers in case of interference of filling systems for treatment products with other ship activity - risk analysis is to be submitted for approval for treatment products tanks if located in category A machinery space - risk analysis is to be provided for compartment containing treatment products tanks.	NR 445, Pt C, Ch 1, Sec 7
		Mandatory if	Accidental situation Depending on the type and service of the unit, a risk analysis may be required to: assess the risk of explosion, collision and dropped objects.	NR 445, Pt B, Ch 2, Sec 1
	HAZID, HAZOP, FRA, ERA, EERA, ESSA, QRA	BV satisfaction	Arrangement of unit Risk analysis is to be performed considering the layout of the unit or installation, in order to: - validate the arrangement - determine accidental loads equipment and systems are capable to withstand. Reference to Recommended Practice API RP 14J, EN ISO 13702, EN ISO 17776.	NR 445, Pt C, Ch 4, Sec 2
	ERA, SCRA, DORA	Mandatory if	Local structural improvements When risk of explosion, collision or dropped objects is considered as relevant, risk analysis is required to assess the corresponding risk.	NR 445, Pt B, Ch 3, Sec 9
offshore access systems (gang-way)	FMEA	Mandatory	Gangway Compliance with the safety principles is to be demonstrated by a FMEA.	NI 629, Sec 1