

**GUIDELINES FOR OFFSHORE ACCESS "WALK TO WORK"
GANGWAY**

CR CLASSIFICATION SOCIETY

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GUIDELINES FOR OFFSHORE ACCESS "WALK TO WORK" GANGWAY

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CHAPTER 1 INTRODUCTION

1.1 Application

1.1.1 The Guidelines for Offshore Access "Walk to work" Gangway (hereinafter referred to as the Guidelines) are applicable for certification of offshore gangways for vessels with class notation **Walk-to-work**.

1.1.2 The Guidelines do not apply to fixed gangways (bridges) permanently installed between two fixed installations, nor for vessel-shore gangways.

1.1.3 The provisions in the Guidelines are to be applied to cargo transfers performed only by means of cargo trolleys over the gangway bridge and service/fluid transfers performed through cables and pipes/hoses fitted with break-away or automatic disconnection devices. The specifics of such systems are to be evaluated on a case-by-case basis.

1.1.4 Cargo transfers performed by motorized vehicles (e.g. fork lift trucks, etc.) and service/fluid transfers performed through permanently connected cables and pipes/hoses are not covered in the Guidelines.

1.2 Scope

1.2.1 General

The Guidelines describe the requirements regarding the certification of the offshore gangways, including:

- (a) documentation requirements
- (b) material and fabrication
- (c) structural design and strength
- (d) functional and safety requirements
- (e) testing and marking.

1.2.2 Category of gangways

The Guidelines cover the following types as related to the operation of the gangway:

- (a) Type I – Uncontrolled flow of people, routine personnel transfer
 - (i) Unrestricted flow of personnel transfer between the connected units (i.e., an unlimited number of personnel may pass the gangway at any given time as long as the total load is within the gangway's design load capacity).
 - (ii) Gangway is supported in X, Y and Z axis directions at both ends.
 - (iii) Gangway is to contain means to self-detach at one end and move away in a safe manner and short time.
- (b) Type II – Controlled flow of people, routine personnel transfer.

- (i) People do not move freely between the connected units; the flow of people is controlled/regulated by means of manual (i.e. the gangway operator) or automatic flow control (i.e., only a specified number of personnel may be present on the gangway at any given time, based on the gangway design).
- (ii) At least one end of the gangway is supported in the X, Y and Z axis directions.
- (iii) Gangway is to contain means to self-detach at one end and move away in a safe manner and short time.

1.2.3 Types of Motion Compensation Systems

The Guidelines covers both passively and actively motion compensated gangways.

(a) Passive Motion Compensation System

A system incorporates features that allow the gangway to accommodate the relative motions between vessels without making use of any external systems or equipment.

(b) Active Motion Compensation System

A system powered by an external power supply that reduces or cancels (compensates) the effect of the vessel motions (from one degree of freedom to all 6 degrees of freedom) on the gangway structure.

1.3 Class Notations

A vessel classed by CR Classification Society (hereinafter referred to as the Society), which has an CR register of offshore access gangway systems permanently installed, is to be affixed by the class notation **Walk-to-Work (Type I or II, PS, or AS)**, as follows:

1.3.1 Type I

The gangway system permits unrestricted flow of personnel transfer within the capacity limitation and is supported at both ends.

1.3.2 Type II

The gangway system permits limited flow of personnel transfer.

1.3.3 PS

The vessel has an installed passive motion compensation gangway system designed, constructed, and tested in accordance with the respective requirements of the Guidelines.

1.3.4 AS

The vessel has an installed active motion compensation gangway system designed, constructed, and tested in accordance with the respective requirements of the Guidelines.

For example, a vessel with an active motion compensation gangway system and the gangway allows personnel to transfer freely is to be assigned the notation **Walk-to-Work (Type I-AS)**. In the case of a vessel with more than one gangway, separate reviews and surveys for each gangway will be required, and multiple gangway systems are to be included in the notation.

1.4 References

While usually not required for the certification of the offshore access gangway itself, the designer is also to be aware of other Rules, standards and regulations that can influence the design; such as IMO MSC.1/Circ. 1331, SOLAS II-1/3-9.

CHAPTER 1 INTRODUCTION

1.4 References

These applicable rules may be extended to conformity assessment in accordance with proprietary specifications or recognized standards as listed below, upon request made to and agreed by the Society.

- 1.4.1 The Rules for the Construction and Classification of Steel Ships (the Rules for Steel Ships), the latest edition.
- 1.4.2 The Rules for the Construction and Classification of High-Speed Craft (the Rules for High Speed Craft), the latest edition.
- 1.4.3 The Rules for the Construction and Survey of Cargo Gear (the Rules for Cargo Gear), the latest edition.
- 1.4.4 ISO 7061: Shipbuilding - Aluminium shore gangways for seagoing vessels
- 1.4.5 EN 1993: Eurocode 3, Design of steel structures
- 1.4.6 EN 1999: Eurocode 9, Design of aluminium structures

CHAPTER 2 DOCUMENTATION AND CERTIFICATION

2.1 Documentation

2.1.1 Documentation to be submitted

(a) General

The documents listed in Table 2-1 below are to be provided, as a minimum. Relevant additional drawings and calculation notes may be requested by the Society in complement to the hereafter mentioned documents.

(b) Design analysis

For structural parts and components in Table 2-1 below, the drawings are to be supplemented with calculations demonstrating that the structural strength complies with the requirements.

The documentations are to contain information regarding objectives, premises, assumptions and conclusions.

A complete listing of structural components and parts subjected to strength calculations is to be submitted.

The list is to include information of:

- (i) types of failures considered (excessive yielding, buckling, fatigue fracture)
- (ii) elastic or plastic analysis performed
- (iii) permissible stress (Work Stress Design, WSD) or limit state method (Load and Resistance Factor Design, LRFD) used.

Table 2-1
Documentation of the Offshore Gangway System to be submitted

Documents	Description	PA/I*
Design criteria	Operational limitations (principal loads, environmental loads, vessel motions, etc) Gangway type	I
Assembly or arrangement drawing	A drawing showing how the parts of a mechanical assembly are arranged together.	I
Detailed drawing	Gangway structure and components for slewing, luffing and telescoping. Winches with brakes (when in use during personnel transfers) Drawings of gears transmitting braking forces are to contain relevant parameters including torque capacity.	PA
Design analysis	See 2.1.1(b)	I
Non-destructive testing plan (NDT) plan	A document describing the methods, extent and criteria for the non-destructive testing that is to be performed.	PA
Design basis	A document describing: <ul style="list-style-type: none"> — regulatory basis for the design, i.e. applicable rules, regulations and standards — design principles applied — environmental conditions — technical specification — gangway operational philosophy. 	I
Functional description	A document describing: <ul style="list-style-type: none"> — all functions incorporated in the system and their technical realization — all interfaces towards other systems, including their technical realization. 	I

CHAPTER 2 DOCUMENTATION AND CERTIFICATION

2.1 Documentation

Test procedure at manufacturer	A document describing the test configuration and test methods for testing at the manufacturer's works, specifying for each test: <ul style="list-style-type: none"> — initial condition — how to perform the test — what to observe during the test and acceptance criteria for each test. The tests are to cover normal modes and failure modes.	PA
Test procedure for quay and sea trial	A document describing the test configuration and test methods for testing at the manufacturer's works, specifying for each test: <ul style="list-style-type: none"> — initial condition — how to perform the test — what to observe during the test and acceptance criteria for each test. The tests are to cover normal modes and failure modes.	PA
Operation manual	See 2.1.2	I
Power supply Arrangement plan	A drawing showing the power supply philosophy from main and back-up source: <ul style="list-style-type: none"> — Electrical supply-A diagram showing the philosophy regarding connection to distribution boards, batteries, converters or uninterruptible power supplies. — Pneumatic supply-A diagram showing connection to compressors, accumulators, reduction valves, dust filter and moisture filter, pipe ratings and dew point. — Hydraulic supply-A diagram showing connection to hydraulic power units, accumulators, pumps and filters, and pipe ratings. 	I
Electrical schematic drawing	A schematic drawing showing the configuration of the electrical circuits. <ul style="list-style-type: none"> — single line diagram of the power distribution system — schematic diagrams of the motor starter cabinet(s) and control/safety system — general arrangement diagram of the gangway showing all essential electrical equipment (electric motor, control panels, limit switch, etc.) with regards to hazardous area, as applicable — justification of the safety character of electrical equipment located in hazardous areas, as applicable 	PA
Electrical equipment list	Including identification of equipment in hazardous areas (as applicable)	I
Hydraulic power system piping and instrumentation diagram	A diagrammatic drawing including the following: <ul style="list-style-type: none"> — components including reference identification (tag numbers) — size of pressure vessels and piping — piping with line numbers — pump type and capacity — type of valves and connections — type of expansion elements — location of shutdown and isolation valves — failure mode of control and shutdown and isolation valves — hydrostatic test pressure after installation on board, where required — instrumentation, including safety devices, control and monitoring equipment — signal lines, sufficient to describe the function 	PA

	<ul style="list-style-type: none"> — heat-tracing cables and insulation for pipelines, valves instruments, vessels, etc. — maximum differential pressure across centrifugal pumps — maximum flow through pumps and compressors — set points for all shutdown and isolation valves and rupture disks — design and operational data for the components — input and output signals from safety systems. 	
Hydraulic control diagram	A schematic diagram showing hydraulic control lines and associated components as actuators, valves and similar. The operational mode that is shown, e.g. normal operation with pressure applied, is to be stated. The failure mode of the components, e.g. close on loss of power, is to be stated.	PA
Hydraulic power system functional description	As above	I
Hydraulic power system equipment list		I
Control and monitoring system documentation	<p>A documentation package providing information corresponding to the following set of documentation types, as relevant:</p> <ul style="list-style-type: none"> — Control system functional description — System block diagram (topology) — User interface documentation — Power supply arrangement — List of controlled and monitored points — Software change handling procedure — Test procedure at manufacturer. <p>Functional description of safety system and the safety equipment to be included</p>	PA
Control and monitoring software quality plan	<p>Document to be sent to the approval centre and describing the software life cycle activities. This document shall, as a minimum, contain the description of the procedures for:</p> <ol style="list-style-type: none"> 1) software and hardware requirements specification 2) software and hardware design and development plans 3) software verification plans 4) software module testing 5) software integration testing 6) software validation, both functionality and failure modes. 	I
Control and monitoring failure mode description	<p>Required for passive compensated gangways.</p> <p>A document describing the effects due to failures in the systems, not failures in the equipment supported by the systems. The following aspects shall be covered:</p> <ul style="list-style-type: none"> — list of failures which are subject to assessment, with references to the system documentation — description of the system response to each of the above failures, including a list of gangway safe positions — comments to the consequence of each of these failures. 	I
Control and monitoring failure mode and effect analysis (FEMA)	<p>Required for active motion compensated gangways.</p> <p>A document where the system response to possible failures are identified and analysed.</p>	I

Fire safety, Structural fire protection drawing	A drawing showing the arrangement of the structural fire protection, including: <ul style="list-style-type: none"> — method of construction — categorization of spaces — horizontal and vertical fire class divisions, including A-0 — main horizontal and vertical fire zones — draught stops — typical method of heat bridge insulation — method of construction of continuous “B” class ceiling or linings contributing to insulation and fire integrity of fire divisions — fire integrity and type of doors in class divisions, including information if self-closing is arranged. 	PA
* To be submitted: PA = for plan approval; I = for information.		

2.1.2 Operation manual

A manual is to be prepared, containing information regarding operation modes, operating instructions for normal and degraded operating modes, operational limitations, user interface description, transfer of control, redundancy, failure detection and identification facilities (automatic, manual), data security, access restrictions, special areas requiring user attention, procedures for start-up, restoration of functions, close-down (e.g. retrieval, parking, etc.). A few guidelines are provided below:

- (a) The operational limitations, such as maximum number of persons on gangway (Live Load, LL), the actual distribution of the LL along the gangway, operational length range, wind speed, maximum luffing angle range, vessel accelerations, etc.
- (b) Normal use of the gangway with information of:
 - (i) deployment/retrieval procedures
 - (ii) operational procedure (preparations prior to personnel transfers, control of flow of people, etc.).
- (c) Emergency procedures with information of:
 - (i) fixed procedures as to when the gangway connection is to be interrupted and when it can be re-established (hazard identification).
- (d) Differentiation/definition of controlled vs auto-lift situations.
- (e) Continuous maintenance and repair routines to ensure that the gangway and all the appurtenant systems function properly at all times.

2.2 Certification

2.2.1 Gangway components certification

Following Table 2-2 and Table 2-3 list the certificate requirements for offshore access gangways.

Table 2-2
Certificate Requirements for Offshore Gangway System

Components	Document*	Remark
Slewing rings	C/E	
Critical Hydraulic cylinders	C/E	Applicable also for accumulators
Winches	C/E	For wire luffing gangways winches ≥ 100 kW
Sheaves	C/E	Manufacturer's document will be satisfactory for un-welded sheaves
Wire ropes	C/E	Alternatively ILO form No. 4
Transmission gears and brakes	W	Applicable when transmitting braking forces for luffing and telescoping
Slewing gear	W	Also other transmission gears for non-critical applications
Hydraulic components	TR	Except mountings
*Symbols: C – Marine Products Certificate; E – Equivalent document; W – Manufacturer's document; TR – Test report, refer to CR Guidelines for Survey of Products for Marine Use, 1.5.2 Products documents.		

Table 2-3
Additional Requirements for Motion Compensating Systems

Components	Document*
Control and monitoring system	C/E
Electrical Motors ≥ 100 kW	C/E
Motor starters and frequency converters ≥ 100 kW	C/E
Slip rings ≥ 100 kW	C/E
*Symbols: C – Marine Products Certificate, E – Equivalent document	

2.2.2 Certification procedure

(a) General

The following activities are covered by the Guidelines:

- (i) design examination
- (ii) survey during fabrication and installation
- (iii) witness testing and marking.

(b) Type approval (Design and Manufacturing assessment)

Load-carrying and other important components of a gangway are subject to design assessment with respect to strength and suitability for its purpose. A type approval is granted when the design and manufacturing assessment have been concluded without detection of non-compliance towards the Guidelines.

The type approval means that the design as approved can be applied for identical units to be fabricated, i.e. requested documents need not be submitted for each unit.

The type approval is based on certain conditions and its period of validity may be limited.

Reference is made to CR Guidelines for Survey of Products for Marine Use, Chapter 3 Type Approval.

(c) Survey during fabrication and installation

Normally, a survey during manufacture of each separate gangway is to be carried out by the Surveyor of the Society in order to ascertain compliance with the approved drawings, other requirements of the Guidelines as well as general good workmanship.

As an alternative to survey during manufacture of each separate gangway, modified survey procedures and survey arrangements may be accepted provided the manufacturer operates a quality-assurance system approved and certified by the Society. Refer to CR Guidelines for Survey of Products for Marine Use, 1.8 Alternative Certification Scheme (ACS).

Before being put into service for the first time, the gangway shall be tested according to the approved "Testing Procedure for quay and sea trial" by a competent person accepted by flag/state authorities.

(d) Testing and marking

Testing and marking is to be performed as per Chapter 7 requirements of the Guidelines.

(e) Extension of scope of work

Upon request from the customer, the scope of work may be extended beyond the subjects and aspects covered in the Guidelines. Extensions are to be agreed in writing. The Society may, if found necessary, require that the customer presents reference documents for the extended scope of work, such as authority regulations, norms and standards.

In case of disputes regarding interpretations of requirements on which extended work is based, the customer is to contact the publisher/owner of the requirements and obtain their written interpretation. If the publisher/owner is not willing to interpret the disputed requirement, or an interpretation for other reasons cannot be acquired, the Society interpretation will prevail.

(f) Reduction of scope of work

Upon request from and agreed with the customer, parts of the scope of work, components, systems or specific aspects or requirements may be excluded from the scope of work specified in the Guidelines. This will be annotated in the documentary evidence of the completed assignment (certificate).

The Society will not agree to limit the scope of work or parts of the suggested services if they are of the opinion that this may lead to hazards or unacceptable lowering of the safety standard.

2.2.3 Certificate

(a) As a minimum the certificate is to contain

- (i) reference to a signed "factory acceptance tests" report
- (ii) design parameters/limitations given in the approval letter or product type approval certificate (PTAC)
- (iii) list of certified sub-components (see para. 2.2.1/Table 2-2, as applicable)
- (iv) reference to valid product type approval certificates/approval letters for the certified sub-components
- (v) list of tests to be carried out after installation onboard (reference to the approved "testing procedure for quay and sea trial").

Note:

The product certificate is issued based on the Approved "Testing Procedure for quay and sea trial" (ref. para. 2.2.1/Table 2-1).

(b) The Marine Product Certificate will issued by the Surveyor upon completion of the project.

2.3 Periodical Survey

2.3.1 General

- (a) It is recommended to have a regular inspection during operational use according to an established plan, either from manufacturer and/or as defined by regulatory bodies.
- (b) Such periodical survey may be required to be carried out by the Society as part of classification's scope Annual Survey. As an alternative, other inspection bodies or the original manufacturer/authorized representative (recognised by flag/state authorities) may carry out such inspections.
- (c) Notwithstanding the above, major repairs or modifications which may alter the certificate is to be approved by the Society.

2.3.2 Gangways included in class scope

Offshore gangways included in the class scope shall be subject to a periodical survey regime as per requirements in Appendix A. The periodical surveys shall be carried out by the Society as part of classification's scope Annual Survey / Special Survey.

CHAPTER 3 MATERIALS AND FABRICATION

3.1 General

3.1.1 This section describes the structural categorization, selection of materials and inspection principles to be applied in design and construction of offshore gangways.

3.1.2 The below requirements for materials for structural members and equipment are applicable for gangways with design temperature T_D down to -30°C . Materials for gangways with design temperature below -30°C may be specially considered. Design temperature is defined in 3.2.

3.1.3 Materials with properties deviating from the requirements in this section may be accepted only upon special consideration.

3.1.4 As an alternative, materials that comply with national or proprietary specifications may be accepted provided such specifications show reasonable equivalence to the requirements or are specially approved.

3.2 Design Temperature, T_D

3.2.1 Design temperature is a reference temperature used as a criterion for the selection of material grades.

3.2.2 The design temperature T_D for offshore gangways is defined as the lowest mean daily temperature (the average temperature during the coldest twenty-four hours of one year).

3.2.3 For gangways installed on vessels classified by the Society, the design temperatures of the gangway and the supporting vessel are recommended to be compatible.

3.2.4 If not otherwise specified, the design temperature is to be -20°C .

3.3 Structural Category

3.3.1 The following categorization will be used for structural members:

- (a) Special: Highly stressed areas where no redundancy for total collapse exists.

Note:

Highly stressed areas are considered to be areas utilized more than 85% of the allowable yield capacity.

- (b) Primary: Structures carrying main load as well as components with highly stressed areas.

- (c) Secondary: Structures other than primary and special members.

3.3.2 Slewing bearings with flanges are normally to be categorized as special, other structure, including the pedestal, transmitting principle loads are normally categorized as primary.

3.3.3 The categories are to be agreed with the Society in each case.

3.3.4 Bolt connections are to be categorized according to 3.5.4.

3.4 Material Manufacture Test, Survey and Certification

3.4.1 Certificates covering specification of the chemical composition and mechanical properties are to be presented for all materials for all load-carrying structures and mechanical components. The test values are to show conformity with the approved specification. Test specimens are to be taken from the products delivered.

3.4.2 For material manufacture testing/retesting, survey and certification procedures and requirements, see CR Guidelines for Survey of Products for Marine Use, Chapter 4 and the Rules for Steel Ships, Part XI Materials, as applicable.

3.4.3 The Society approved material manufacturer will not be required.

3.4.4 For slewing rings with bolts, nuts, washers, etc., inspection certificates issued by the mill or material manufacturer are to be submitted to the Surveyor for verification.

3.4.5 The materials are to be adequately marked for identification. The marking is to at least comprise name or trade mark of the manufacturer, material grade, heat number.

3.4.6 Marking and identification of smaller items, e.g. bolts and nuts, are to be specially agreed upon between manufacturer and the Society, but are to at least comply with fastener product standard.

3.4.7 Materials without proper identification are to be rejected unless renewed testing verifies compliance with approved specifications. The number and type of tests will be decided in each case.

3.5 Structural Materials

3.5.1 Rolled structural steel for welding

(a) General

Certificates covering specification of the chemical composition and mechanical properties are to be presented for all materials for all load-carrying structures and mechanical components.

The requirements to chemical composition, mechanical properties, etc. are given in Part XI, Chapter 3 of the Rules for Steel Ships.

As an alternative, materials that comply with national or proprietary specifications may be accepted provided such specifications show reasonable equivalence to the requirements or are specially approved.

The grade of steel to be used is in general to be related to the service temperature and thickness for the applicable structural category.

(b) Impact test

Required impact test temperatures are dependent on design temperature T_D and the material thickness.

Impact test temperatures are given in Table 3-1 below for structural steel for special, primary and secondary applications. For definition of design temperature, see 3.2.

For structural members subjected to compressive and/or low tensile stresses, modified requirements may be considered, i.e. greater material thicknesses for the test temperatures specified.

Impact test temperature for flanges for slewing bearings is to be as for primary members given in Table 3-1 based on actual thickness.

When welding a thinner plate to a thicker plate, e.g. connecting a flange to the supporting structure for the flange, inserted reinforcement rings etc., the following is to apply, provided that the thicker plate does not contain butt welds:

The impact test temperature is to be the lower of the temperatures according to Table 3-1, based on t_1 or $0.25 \times t_2$ where:

t_1 = thickness of the thinner supporting plate

t_2 = thickness of the flange.

However, the impact test temperature for the flange (thicker plate) is not to be higher than the required test temperature, based on t_2 according to Table 3-1, plus 30°C.

Table 3-1
Impact Test Temperatures for Welded Structural Steel

Material thickness t in mm	Impact test temperature in °C ⁽¹⁾	
	Structural steel for special and primary members ⁽²⁾	Structural steel for secondary members ⁽²⁾
$6 \leq t \leq 12$ ⁽³⁾	$T_D + 10$	Test not required
$12 \leq t \leq 25$	T_D	Test not required
$25 \leq t \leq 50$	$T_D - 20$	T_D
$t > 50$	$T_D - 40$	$T_D - 10$
Note: (1) For steel with yield stress below 500 MPa, the test temperature need not be taken lower than -40°C. For steel with yield stress above 500 MPa, the test temperature is not to be taken higher than 0°C and not lower than -60°C. (2) See 3.3 for definitions of structural category. (3) For plate thickness less than 6 mm, Charpy V-notch testing will not be required.		

3.5.2 Rolled structural steel not for welding

(a) General

Rolled steel for special and primary components other than those mentioned in 3.5.2(b) and 3.5.2(c) of this Section (e.g. mechanisms) is to be specified with reference to a recognized standard. The material is to be delivered in the following conditions:

- (i) Carbon and carbon/manganese steel in normalized condition
- (ii) Alloy steel in quenched and tempered condition
- (iii) As Rolled (AR) condition, when subjected to special consideration.

For all materials, impact toughness is to be documented by Charpy V-notch impact tests. Test temperatures are to be as specified in Table 3-2 below but, in the case of low calculated stresses, e.g. not exceeding 50 N/mm², a test temperature of 20°C will be accepted. Required minimum impact energy is to be as required for welded parts, refer to appropriate requirements of Table XI 3-9, 3-10, and 3-11 of the Rules for Steel Ships.

Table 3-2
Impact Test for Rolled Steel not for Welding

Material thickness t in mm	Impact test temperature in °C
$t \leq 10$	Impact test not required
$10 < t \leq 50$	$T_D + 20$
$50 < t \leq 100$	$T_D + 10$
$t > 100$	T_D

(b) Bolts and nuts

Materials for bolts and nuts are to comply with the requirements in 3.5.4 for bolts and nuts. This includes requirements for chemical composition and mechanical properties.

(c) Rolled rings

Rolled rings for important components such as slewing rings, toothed wheel rims etc. are to comply with the requirements for steel forgings, see 3.5.3.

3.5.3 Steel forgings

(a) Steel forgings

- (i) Steel forgings are to comply with the requirements in Part XI, Chapter 8 of the Rules for Steel Ships.
- (ii) As an alternative, materials that comply with national or proprietary specifications may be accepted provided such specifications show reasonable equivalence to the requirements in 3.5.3(a)(i) above or are specially approved. As a minimum the following particulars are to be specified: manufacturing process, chemical composition, heat treatment, mechanical properties and non-destructive testing. For machinery components, see Part IV, Chapter 6 of the Rules for Steel Ships.
- (iii) Impact testing requirements are not to be less than those in Table 3-3 below.

Table 3-3
Impact Test for Steel Forgings

Design temperature T_D	Test temperature	Minimum Charpy value
$T_D \geq -20^\circ\text{C}$	0°C	27 J
$-20^\circ\text{C} > T_D > -30^\circ\text{C}$	-20°C or (0°C)	27 J (48 J for $0^\circ\text{C } T_D$)

(b) Forged rings for slewing bearings

Specifications of slewing rings essential for the structural and operational safety of the gangway are subject to individual approval by the Society. All relevant details are to be specified such as chemical composition, mechanical properties, heat treatment, depth and hardness of surface hardened layer and surface finish of fillets. Position of test specimens are to be indicated. Method and extent of non-destructive testing are to be specified and the testing procedures are to be stated. Detailed information about method of manufacture is to be submitted.

For each new material of which the manufacturer has no previous experience and for any change in heat treatment of a material previously used, a principal material examination is to be carried out. This means that the Society may impose additional requirements not specified in the Guidelines. The results are to be submitted to the Society for consideration. The programme for such examination is to be agreed with the Society.

All test results are to comply with the approved specifications.

Steel for slewing rings is to satisfy the requirements of Table 3-4 below.

Table 3-4
Slewing Materials

Heat treatment		According to approved specification
Charpy V-notch test temperature		T _D
Charpy V-notch value	Average	42 J
	Single min. value	27 J
Elongation		14%
Fatigue properties		Documentation may be required by type tests on specimen of ring section.
Fracture toughness		Documentation may be required by type tests on specimen of ring section in question.

3.5.4 Bolts and nuts

- (a) Bolt connections are normally considered to be in the following groups:
 - (i) Special – where it is part of a slewing ring connection.
 - (ii) Primary – where the bolts or nuts are transferring principle loads.
 - (ii) Secondary – where the bolts or nuts are transferring load, not belonging in the category special or primary. Examples are bolt connections in driver's cabin, platforms, stairs and ladders.
- (b) Bolts and nuts for use in connections categorized as special or primary are to conform with and be tested in accordance with a recognized standard, e.g. pertinent parts of ISO 898 or other recognized standard.
- (c) Additional requirements to testing and inspection of slewing ring bolts are given in Table 3-5 below.

Table 3-5
Testing and Inspection of Slewing Ring Bolts

Strength Class, ISO 898, or equivalent	Diameter d in mm	Ultimate strength N/mm ²	Yield strength. Minimum N/mm ²	Elongation	Required Charpy V energy ⁽¹⁾ at test temp. as required for rings Table 3-3	Fracture mechanics testing (CTOD)	Surface inspection ⁽²⁾
Grade 8.8	d < 25	800 - 1000	640	14	—	—	Visual
	d ≥ 25				42J	—	Visual and magnetic particle (MPI)
Grade 10.9 ⁽³⁾	d < 25	1000 - 1200	900	12	—	—	Visual
	d ≥ 25				42J	—	Visual and magnetic particle (MPI)

Note:

- 1 Average value. Single value accepted to be 30% lower.
- 2 For all the bolts (100%), magnetic particle testing is to be carried out at least 48 hours after completion of quenching and tempering for bolts with yield strength above 355 N/mm². Inspection is to be in accordance with ASTM E 709 or other recognized standards accepted by the Society.
Depth of longitudinal discontinuities is not to exceed 0.03 of the nominal diameter. Transverse cracks will not be acceptable irrespective of crack depth and location. Other surface irregularities will be considered in each case.
- 3 Bolt material having minimum specified yield strength higher than 1100 N/mm² will normally not be accepted.

- (d) Bolt connections considered as secondary are to be made from suitable materials.
- (e) Nuts may be accepted to be in one strength class lower than the bolts of bolt/nut assemblies.
- (f) Bolts and nuts are to be delivered with the following certificates as per the recognized standards, verifying compliance with the service conditions specified in such standards:
 - Inspection certificate for slewing ring bolts and nuts.
 - Test report for bolts and nuts in primary and secondary connections.
- (g) Slewing ring bolts are to have rolled threads, and the rolling is to be performed after final quenching and tempering of the bolts. Grade 12.9 bolts are not accepted as slewing ring bolts.
- (h) Fasteners (bolts, nuts and washers) in marine environment are normally to be hot-dipped galvanized or sherardized with coating thickness min. 50 micrometer. If special thread profiles or narrow tolerances prohibit such coating thickness, bolts/nuts may be supplied electro-plated or black provided properly coated/painted after installation. Pickling and electro-plating operations are to be followed by immediate hydrogen-relief (degassing) treatment to eliminate the risk of hydrogen embrittlement.
- (i) Galvanizing of bolts and nuts are acceptable provided additional loss of bolt load (pretension) of at least 4% is compensated for.

3.5.5 Steel castings

Steel castings are to comply with the requirements in Part XI, Chapter 6 of the Rules for Steel Ships.

3.5.6 Steel pipes, tubes and fittings

Steel pipes, tubes and fittings are to comply with the requirements in Part XI, Chapter 5 of the Rules for Steel Ships.

3.5.7 Aluminium alloys

Aluminium alloys are to comply with the requirements in Part XI, Chapter 11 of the Rules for Steel Ships.

3.5.8 Steel wire ropes

Steel wire ropes are to comply with the requirements in Part XI, Chapter 14 of the Rules for Steel Ships.

3.6 Fabrication and Testing

3.6.1 General

- (a) The manufacturer is to have a system for quality control involving competent personnel with defined responsibilities that are to cover all aspects of quality control. For qualification of welders, reference is made to Part XII, Chapter 3 of the Rules for Steel Ships. The materials are to be identifiable during all stages of manufacturing and construction.
- (b) Manufacturing and construction are to be in accordance with the approved drawings and specifications. The specification is to refer to recognized codes, standards or rules relevant for the structure in question. Supplementary requirements amending the reference documents may be stipulated.
- (c) Dimensional tolerances specified in the design analysis of the gangway structures are to be complied with during manufacturing and construction.
- (d) All defects and deficiencies are to be corrected before the structural parts and equipment are painted, coated or made inaccessible.
- (e) Alternative methods of making joints may be considered by the Society and will be subject to consideration in each case.

3.6.2 Forming of materials

(a) General

Forming and straightening of materials are to be performed according to procedures which outline the succession of the controlled steps. Such work is to be controlled by the contractor.

(b) Cold forming of ferritic steels

- (i) The degree of cold deformation of special and primary structural elements of material strength grades up to 690* is to be less than 5%, unless otherwise agreed and qualified.

The contractor is to prepare a procedure for cold forming before the production starts, and the procedure is to be agreed.

Maximum cold forming ratio of material strength grades 890* and 960* is to be agreed.

Note:

* For steel grades 690, 890, 960, see Part XI, Chapter 3, Table XI 3-6, Table XI 3-11 of the Rules for Steel Ships.

- 1. Qualification by adequate testing is advised, e.g. tensile test and impact tests of representatively strained and strain aged material.

2. Weldability test may be considered.
- (ii) Cold forming with theoretical deformation exceeding 5% and up to a maximum deformation of 12% may be accepted for material strength grades up to 690 subject to additional testing of representatively cold formed material, e.g. strain age testing. The average impact energy after strain ageing is to meet the impact requirements specified for the grade of steel used. Unless otherwise agreed, each cast represented is to be tested.

Note:

1. Strain age test is applicable to C-Mn-steels and low alloy steels. In addition to representative cold forming, representative cold formed material means at least same material grade, with similar chemical composition and mechanical properties, and from one steel manufacturer. For destructive testing, the following are to be tested as a minimum: impact toughness tests of representatively strained material and strain aged material. Test temperature is to be the same as required for the base metal.
 2. Where certified elongation for the material to be cold formed, minus calculated theoretical deformation gives a value lower than 9%, tensile test of strained material is advised. Measured residual elongation is to be more than 10%.
- (iii) Cold deformation exceeding 12% and up to maximum 20% and followed by heat treatment may, subject to agreement, be considered for acceptance case by case based on qualification.

Note:

The contractor is to prepare a procedure for qualification, and the procedure is to be agreed before the production starts. The qualification procedure is to at least include non-destructive, destructive and weldability testing of representative cold formed material. For destructive testing, at least full scope of testing as for qualification of the base metal is to be required, although additional testing will typically be required, e.g. testing at different thickness locations, drop weight testing, etc. The testing is to include strain age testing.

- (iv) Cold forming exceeding 20% is in no case to be carried out.
- (v) If welding is applied in areas cold formed to more than 5%, special consideration is to be taken with respect to material properties and subsequent cracking, e.g. by additional inspection and NDT. See also (vi) below.
- (vi) All cold formed (more than 5%) and heat treated areas are to be tested 100% by MT (or PT for stainless steels) after final forming, heat treatment and welding.
- (vii) The theoretical plastic deformation ϵ (%) is to be calculated by the following simplified formulas:
- (1) Single-curvature deformation
Cold rolling or pressing of plates to cylindrical forms:

$$\epsilon = \frac{t}{2R_c + t} \times 100$$

Cold bending of straight pipes to bends:

$$\epsilon = \frac{D}{2R_c} \times 100$$

- (2) Double curvature deformation
Forming of plates to spheres:

$$\epsilon = \frac{t(1 + \nu)}{2R_c} \times 100$$

Where:

D	=	outside diameter of pipe or vessel, mm
ϵ	=	theoretical plastic deformation, %
R_c	=	forming radius (inner radius of bend), mm
t	=	material thickness, mm
ν	=	Poisson's ratio (0.5 for plastic condition).

(c) Hot forming of ferritic steels

Forming of steels at high temperatures is to be effectuated with due regard to adverse effects of the material properties. Forming of steels above 650°C is to be subject to agreement.

3.6.3 Welding

All aspects relating to welding (i.e. welding procedures, consumables, welding preparations, welding performance, repairs, heat-treatment, production, inspection, NDT and acceptance criteria) are to comply with the requirements in Part XII of the Rules for Steel Ships.

3.6.4 Non-destructive testing acceptance criteria for components machined after forged/cast

(a) Acceptance criteria from the following documents can be used for NDT of machined components, unless otherwise specified in the approved manufacturer's specification:

- (i) For forged components:
IACS Recommendation no.68, Inspection zone 1.
- (ii) For cast components:
IACS Recommendation no.69, Quality level 1.

(b) NDT testing is to be focused on critical areas. Extent to be specified by the manufacturer and is to be according to recognized standards.

Note:

The objective and scope of quality control for materials, material testing and documentation thereof is to verify that the relevant properties as specified by the designer and accepted by the Society are obtained.

3.6.5 Material protection against corrosion

(a) Steel

Steel surfaces exposed to marine atmospheric conditions are to be protected by a suitable coating system.

Steel surfaces to which application of coating is not possible and which are exposed to internal corrosive conditions are to be protected by other protective systems such as oil, grease, grouting etc.

Bolts, nuts and associated elements are to be protected by hot-dip galvanizing according to relevant standards, e.g. BS 729 or ASTM A 153-82. Alternatively they may be fully encapsulated and the open space be filled with inhibited oil, grease etc.

Other protection methods may be accepted upon special consideration by the Society.

(b) Aluminium

(i) General

- (1) Loss of structural strength due to corrosion is not acceptable.
- (2) All surfaces that are not recognised as inherently resistant to the actual marine environment is to be adequately protected against corrosion.

(ii) For information and approval

- (1) Selection and combination of materials for exposure to sea water and/or marine atmosphere are subject to approval.
 - (2) A sound anti-corrosion coating is always to be combined with the anti-fouling coating on the external hull.
 - (3) Anti-corrosion coating is not to contain copper or other constituents that may cause galvanic corrosion on the aluminium hull.
 - (4) Hull integrated water ballast tanks and other tanks holding corrosive liquids are to be coated. All stiffeners and frames in these tanks are to be welded to plating with double continuous welding.
 - (5) In other internal compartments of the hull where corrosive water is likely to occur, the lower 0.5 m of the internal bottom surface, measured along the plate on each side of the keel, and the corresponding section of the bulkheads, is normally to be coated. The preparation of surfaces including welds and edges is to be such that the coating can be properly applied.
- (iii) Cathodic protection
- (1) Cathodic protection of aluminium hulls can be obtained with aluminium or zinc sacrificial anodes or impressed current. Magnesium based sacrificial anodes are not to be used, and impressed current is not to be used in internal hull compartments.
 - (2) Cathodic protection is normally to be applied to aluminium hull craft due to electrical connection of the aluminium with another metals (in propeller, waterjet, etc.), which may initiate galvanic corrosion, and to protect the hull against local corrosion and damage that normally will occur in protective coatings.
 - (3) The designed (target) service life of a cathodic protection system is normally to be at least as long as the expected time interval between dockings.
 - (4) With impressed current cathodic protection systems, precautions are to be taken to avoid:
 - a) overprotection or excessive negative potential differences locally, specially on aluminium surfaces (implying transpassive corrosion) as well as
 - b) loss of protection, by means of anode screens, automatic voltage control, overprotection alarm, or similar. The protective potential difference is to be kept within a specified and agreed range.
 - (5) Direct voltage stray currents may impose rapid electrolytic corrosion damage to hulls and is to be avoided.
- (iv) Other materials in contact with aluminium
- (1) If other metallic materials are used in propellers or impellers, piping, pumps, valves, etc. and are in contact with the aluminium hull, provisions are to be made to avoid galvanic corrosion. Acceptable provisions are either one of or a combination of:
 - coating of water or moisture exposed surfaces
 - electrical isolation of different materials from each other
 - cathodic protection.

Other protection methods may be accepted upon special consideration by the Society.

(c) Steel and aluminium connections

- (i) In areas exposed to green sea/ sea spray, a non-hygroscopic material is to be applied between steel and aluminium in order to prevent galvanic corrosion. Bolts with nuts and washers are to be of stainless steel, quality A4-316 or equivalent.
- (ii) Horizontal inertia forces in bolted connections may be required to be taken up by metal to metal stoppers with insulation tape in the gap.
- (iii) Aluminium superstructures that are provided with insulating material between aluminium and steel are to be earthed to the hull.

CHAPTER 4 STRUCTURAL DESIGN AND STRENGTH

4.1 Design Loads

4.1.1 General

- (a) The loads to be considered in the analysis of structures are divided into:
 - (i) principal loads (see 4.1.2)
 - (ii) vertical loads due to operational motions (see 4.1.3)
 - (iii) horizontal loads due to operational motions (see 4.1.4)
 - (iv) loads due to climatic effects (see 4.1.5)
 - (v) loads due to motion of the vessel on which the gangway is mounted (see 4.1.6).
- (b) The determination of the loads specified by the designer is to be documented with enclosed calculations, references to standards, or other justification.
In addition to the below stated loads, other relevant loads are to be considered, as applicable.

4.1.2 Principal loads

- (a) The loads due to dead weight of the components: self-weight of the structure and all installed equipment;
- (b) the loads due to live load.
- (c) In addition, the following loads are to be considered, as applicable:
 - (i) Loads due to self-weight of:
 - (1) personnel waiting area (see 5.6)
 - (2) access to the gangway and/or waiting area (see 5.6)
 - (3) driver's cabin.
 - (ii) Loads due to live loads on:
 - personnel waiting area (see 5.6).

4.1.3 Vertical loads due to operational motions

Vertical refers to the coordinate system of the gangway (Z axis direction).

- (a) Inertia forces due to acceleration or deceleration of vertical motions
Forces are to be determined on the basis of the maximum possible acceleration with the given machinery, and on the basis of the maximum possible deceleration with the given brakes. Typically, forces of this type occur by starting and stopping of luffing motions (e.g. during deployment/retrieval of the gangway).
The inertia forces are to be taken into account by multiplying the self-weight of the gangway by a "dynamic factor - DF_z" (see para. 4.3.4/Table 4-4 and Table 4-5 Note 2).
The dynamic factor is to be calculated by the designer based on the stiffness of the gangway taking into account all elements from gangway tip to pedestal; however, it is not to be less than 1.10.
For the dynamic case (LC 2b), these are to be added to the vertical vessel acceleration.

4.1.4 Horizontal loads due to operational motions

Horizontal refers to the coordinate system of the gangway (Y axis direction). It is assumed that horizontal is so defined that it corresponds to physical horizontal in the ideal position with zero “heel” and “trim” of the vessel/unit on which the gangway is mounted.

It is to be noted that these horizontal forces act in addition to possible simultaneously acting horizontal components of the principal loads, see 4.1.2.

(a) Inertia forces due to acceleration or deceleration of horizontal motions

- (i) Forces are to be determined on the basis of the maximum possible acceleration with the given machinery, and on the basis of the maximum possible deceleration with the given brakes. Typically, forces of this type occur by starting and stopping of slewing motions. The inertia due to angular acceleration/deceleration of rotating machinery components is to be taken into account when this effect is significant.
- (ii) The lateral force to be applied at the gangway (bridge) center of gravity (CoG) is to be calculated based on the below formula:

$$F_H = (SW/100) \times (2.5 + 0.1 \times r \times n) \geq 5\% \times SW \quad (\text{kg})$$

where:

- F_H = lateral force
- SW = gangway self-weight (kg)
- r = radius/distance from revolving axis to gangway (bridge) CoG (m)
- n = revolutions per minute

- (iii) Alternatively, the inertia forces are to be taken into account by multiplying the self-weight of the gangway by a “dynamic factor – DF_Y ” (see para. 4.3.4/Table 4-4 and Table 4-5 Note 2); DF_Y is not to be less than 1.05.
- (iv) For the dynamic case (LC 2b), these are to be added to the relevant horizontal vessel acceleration (longitudinal/transverse).

(b) Centrifugal Forces (CF)

- (i) The centrifugal/radial force may be determined on the basis of maximum angular velocity and radius to the considered mass and is to be calculated based on the below formula:

$$CF = (SW/1000) \times (n^2 \times r) \quad (\text{kg})$$

- (ii) For the dynamic case (LC 2b), these are to be added to the relevant horizontal vessel acceleration (longitudinal/transverse).

4.1.5 Loads due to climatic effects

(a) Wind load

- (i) Generally, the wind loads on the gangway is to be calculated according to the Rules for Steel Ships, Part III, Chapter 13. Other internationally recognized standards may be used for a more complex approach.
- (ii) The below wind speed values are considered speed at 10 m above ground (or sea level). The wind speed/pressure is to be modified accordingly for the gangway location with the variation of height. The design wind velocity and pressure are to be based on one-minute mean gust wind speed at the gangway location.
 - (1) For the operational case, the design wind speed is not to be less than 20 m/s. The gangway is to be parked when the one-minute mean gust wind speed exceeds this value.

- (2) For the deployment/retrieval case, the design wind speed is not to be less than the “Operational design wind speed” – recommended value: 36 m/s.
 - (3) For the transit/survival/parked case, the design wind speed is not to be less than 44 m/s.
 - (iii) For gangways intended to be installed and/or operated on offshore installations compliant with the MODU Code, the gangway design wind speeds (for operational, deployment/retrieval and transit/survival cases) are to be in accordance with MODU Code Chapter 3 requirements (i.e. 51.5 m/s transit/survival/parked wind speed).
 - (iv) For gangways that are to be installed on vessels intended to “maintain station” or “wait on weather”, the gangway design wind speed for the parked/transit case is to be correlated with the maximum wind speed that the supporting vessel is designed to operate in (e.g. when the wind speed is expected to be higher than 44 m/s or 51.5 m/s).
- (b) Vortex induced oscillations
- Consideration is to be given to loads from vortex shedding on individual elements due to wind, current and waves. Vortex induced vibrations of frames are also to be considered. The material and structural damping of individual elements in welded steel structures are not to be set higher than 0.15% of critical damping.
- The problem of wind induced VIV (vortex induced vibrations) of members in space frame offshore structures is to be treated as an on-off type. Either the member will experience vibrations and then there is a fatigue problem or it will not experience vibrations and then there is no danger of fatigue cracks.
- Such members are therefore to be designed according to an avoidance criterion that will ascertain that the structure will not vibrate.
- (c) Sea pressure loads (green sea loads)
- These loads will vary according to vessel type and the actual location of the gangway on vessel; in general environmental loads on MOUs will be less than those on ships.
- Sea pressure loads are to be calculated according to CSR-H Pt.1 Ch.4 Sec.5[1].

4.1.6 Loads due to motion of the vessel on which the gangway is mounted

- (a) Vessel motions are dependent on the vessel/MOU on which the gangway will be installed, as well as on the specific location of the gangway on the supporting vessel.
- (b) The vessel/MOU accelerations for the parked/transit/survival case is to be based on the extreme values given in the governing code for the supporting vessel/MOU.
- (c) The vessel accelerations for the operational and deployment/retrieval cases are to be stated by the designer.
- (d) The inertia forces caused by the vessel motions are to be combined according to relevant rules/calculations for the vessel/MOU considered. Alternatively, combinations of the maximum values may be used:
 - (i) vertical force alone
 - (ii) vertical and transverse force
 - (iii) vertical and longitudinal force
 - (iv) vertical, transverse and longitudinal force.
- (e) Typical values for the calculated accelerations may, for a circa 180 m ship with 60,000 tonnes displacement and the gangway near the bow/aft, be:
 - (i) Combined vertical acceleration: $a_v = 1.0 \cdot g$
 - (ii) Combined transverse acceleration: $a_T = 0.7 \cdot g$
 - (iii) Combined longitudinal acceleration: $a_L = 0.3 \cdot g$

Combined means that the acceleration is a result of all the ship motion (surge, sway, yaw, heave, roll and pitch). Gravity is, however, not included.

4.1.7 Gangway subject to exceptional loads

- (a) Exceptional/accidental loads are loads related to abnormal operations or technical failure. Examples of accidental loads are loads caused by:
 - (i) dropped objects
 - (ii) collision impact
 - (iii) explosions
 - (iv) fire
 - (v) extreme vessel accelerations
 - (vi) extreme wind.
- (b) Relevant accidental loads are to be determined on the basis of an assessment and relevant experiences. The acceptance criteria for design accidental loads is to be established prior to carrying out the safety assessment. The level of acceptance criteria is to follow normal industry practice.
- (c) Accidental load combinations are to be evaluated on a case-by-case basis. Stress acceptance levels are to be as per load case III.

4.2 Load Combinations

4.2.1 General

- (a) Listed below are six general load combinations to be considered. Applicability of each load combination, as well as any additional relevant load combination(s) is to be evaluated and agreed with the Society on a case-by-case basis.
 - (i) Normal working condition, the gangway in operation mode (transferring people to-from another unit). (Load case I and II)
 - (ii) In uplift situation (deployment/retrieval). (Load case I and II)
 - (iii) Emergency lift off. (Load case III)
 - (iv) Parked position. (Load case II and III)
 - (v) Test load. (Load case III)
 - (vi) Offshore lifting.
- (b) For gangways intended to be installed on the supporting vessel/unit offshore, the gangway structure is also to be evaluated for the offshore lifting case; the assessment is to be based on an internationally recognized standard.

Note:

For load case I, II and III permissible stresses with respect to yielding and buckling, see 4.3.

- (c) It is recommended that a sensitivity analysis is performed in order to identify all the operational and transit configurations (positions) of the gangway and the corresponding environmental loads, including loads due to vessel motions, acting on the gangway for each configuration. Based on this, the gangway structure is to be dimensioned for the most unfavorable condition(s).

A general overview of the proposed load combinations for type I and II gangways is presented in para. 4.3.4/Table 4-4 and Table 4-5.

4.2.2 Normal working condition

- (a) The following normal working conditions are defined:
 - (i) Principal Loads: self-weights and live loads as per 4.1.2
 - (ii) Loads due to climatic effects: as per 4.1.5; wind speed: “operational”
 - (iii) Loads due to motion of the vessel on which the gangway is mounted (maximum operational accelerations), ref. 4.1.6.
- (b) Other relevant conditions are to be agreed with the Society on a case by case basis.

4.2.3 Deployment/retrieval (gangway in uplift situation)

- (a) The following uplift conditions are defined:
 - (i) Principal loads: self-weights and live loads as per 4.1.2.
Note:
Live loads on gangway and waiting area assumed to be 0.
 - (ii) Vertical loads due to operational motions as per 4.1.3.
 - (iii) Horizontal loads due to operational motions as per 4.1.4.
Note :
Unless luffing and slewing are performed at the same time, the effect of the Vertical and Horizontal loads needs not to be combined.
 - (iv) Loads due to climatic effects: as per 4.1.5; wind speed: ‘Deployment/retrieval’.
 - (v) Loads due to motion of the vessel on which the gangway is mounted (maximum operational accelerations), ref. 4.1.6.
- (b) Other relevant conditions are to be agreed with the Society on a case by case basis.

4.2.4 Emergency lift-off

- (a) The following emergency lift-off conditions are defined:
 - (i) Principal loads: self-weights and live loads as per 4.1.2.
 - (1) live load on gangway applied at tip
 - (2) gangway length: maximum operational length plus safety length.
 - (ii) Vertical loads due to operational motions as per 4.1.3.
 - (iii) Loads due to climatic effects: as per 4.1.5; wind speed: ‘Deployment/retrieval’.
 - (iv) Loads due to motion of the vessel on which the gangway is mounted (maximum operational accelerations), ref. 4.1.6.
- (b) Other relevant conditions are to be agreed with the Society on a case by case basis.

4.2.5 Parked position/Transit

- (a) The gangway is parked when completely pulled-in and supported at the free-end in a cradle/bridge rest:
 - (i) Principal loads: self-weights as per 4.1.2
 - (ii) Loads due to climatic effects: as per 4.1.5; wind speed: “transit/survival”

- (iii) Loads due to motion of the vessel on which the gangway is mounted (maximum transit/survival accelerations), ref. 4.1.6.
- (b) Additional considerations:
 - (i) Increased abrasion on part of the gangway system. The hydraulic luffing cylinders are a typical example of parts that may be exposed to increased abrasion. During the gangway's operating condition, the hydraulic cylinders are usually exposed to less than 2×10^5 load cycles. If the hydraulic cylinders are part of the system supporting the bridge in transport condition, they are exposed to additionally 10^8 load cycles due to ship movement. Even if the loading in transport condition is smaller than those in working condition, the transport condition may, due to the large amount of cycles (500 times more cycles than that for working condition) be of significance when considering the expected life duration of the cylinders.
 - (ii) The design check of a gangway does not cover investigations whether the gangway interferes with other equipment onboard the ship. For example, if the bridge points along the ships longitudinal axis, the transverse displacement of the bridge tip in a storm may be significant. The ship buyer/owner is to, ensure that the gangway does not interfere other equipment, not only for working condition, but also for transport condition.
 - (iii) Calculation of natural-frequencies and eigenmodes is normally not covered. The natural period of the bridge is quite different when the bridge rests in a cradle compared to when it is supported by hoisting wire and/or luffing cylinders. If, for instance, the ship movement has the same period as a natural period for the bridge, quite a dynamic amplification of the displacements in the bridge may occur. Additional securing systems for the bridge may be required if the in-service experience of the gangway shows that large vibrations may occur under transport condition.

4.3 Strength Calculations

4.3.1 General

- (a) It is to be shown that structures and components have the required safety against the following types of failure:
 - (i) Excessive yielding (see 4.3.2)
 - (ii) Buckling (see 4.3.3)
 - (iii) Fatigue fracture (see 4.3.4).
- (b) The safety is to be evaluated for the load combinations defined in 4.2. For each of these cases and for each member or cross section to be checked, the most unfavorable position and direction of the forces are to be considered.
- (c) The strength calculations are to be based on accepted principles of structural strength and strength of materials. When applicable, plastic analysis may be used. If elastic methods are not suitable to verify safety, for instance due to pre-stressing, plastic analysis may be required.
- (d) The verification of safety may be based on the permissible stresses method (work stress design, WSD) or the limit state method (load and resistance factor design, LRFD). With the factors given in the Guidelines there will be only a formal difference between the two methods. If LRFD method is used, LRFD load factors in Table 4-1 are to be applied.

Table 4-1
LRFD load factors

Combination of loads	Load categories			
	G	Q	E	D
(a)	1.3	1.3	0.85	1.0
(b)	1.05	1.05	1.3	1.0
G = permanent load (self-weight of the structure and all installed equipment, vertical and horizontal loads due to operational motions) Q = variable functional load (live load) E = environmental load (loads due to climatic effects, loads due to motion of the vessel on which the gangway is mounted) D = deformation load				

- (e) For steel structures, the capacity check is normally to be based on CR Rules and Standards or alternatively other internationally recognized standards (e.g. EN 1993-1).
- (f) For aluminium structures, the capacity checks are normally to be based on internationally recognized standards (e.g. EN 1999-1).
- (g) For structures with nonlinear behavior, however, significant differences may occur. In such cases the limit state method is to be used, or the safety factor is to refer to load and not to stresses.

4.3.2 Checking with respect to excessive yielding

(a) General

With reference to method of analysis and method of verification of safety given in Table 4-2, σ_y is the guaranteed minimum yield strength (or 0.2% proof stress). If σ_y is higher than 0.8 times the ultimate strength σ_u , it is to be used $0.8 \times \sigma_u$ instead of σ_y .

When using elastic analysis for cases of combined stresses, the permissible stresses (or the required safety factors) given in Table 4-2 refer to the equivalent stress according to von Mises. Local peak stresses in areas with pronounced geometrical changes may be accepted by case by case evaluation.

Joints are not to be weaker than the minimum required strength of the members to be connected. For riveted joints, bolted joints, friction-grip joints, and welded joints the design is to be based on an internationally recognized standard.

(b) Aluminium

In the case of welded connections, the respective mechanical properties in the welded condition are to be assumed. If these values are not available, the corresponding values in the soft condition are to be assumed.

For aluminium structures, the safety factors in Table 4-2 are to be multiplied with an additional safety factor, $SF_{AL} = 1.05$.

Table 4-2
Criteria for the Checking with Respect to Excessive Yielding

Method of verification		Load Case I	Load Case II	Load Case III
Safety factor	Elastic analysis	1.50	1.33	1.10
	Plastic (ult. str.) analysis	1.69	1.51	1.25
Permissible stresses	Elastic analysis	$\sigma_y / 1.50$	$\sigma_y / 1.33$	$\sigma_y / 1.10$

4.3.3 Checking with respect to buckling

- (a) The guiding principle is that the safety against buckling is to be the same as the required safety against the yield limit load being exceeded. This principle indicates that the factors given in the second line of Table 4-2 above is to represent the normal requirement. However, other values may be required or allowed, for instance due to uncertainty in the determination of the critical stresses (or load) or due to the post-buckling behavior. Required factors are given for various types of buckling in Table 4-3 below.

Table 4-3
Safety Factors for the Checking with Respect to Buckling

Type of buckling	Load Case I	Load Case II	Load Case III
Elastic buckling	1.86	1.66	1.38
Elastic-plastic buckling	1.69	1.51	1.25

- (b) The safety factors given in Table 4-2 above are based on the assumption that the critical stresses (or loads) are determined by recognized methods, taking possible effects of geometrical imperfections and initial stresses into account. Elastic buckling in Table 4-3 above means that elastic buckling stress does not exceed the yield strength.
- (c) Calculation methods and corresponding required safety factors as specified by other internationally recognized standards for structural design may also be used.

4.3.4 Checking with respect to fatigue

- (a) Checking with respect to fatigue is to be based on an internationally recognized standards applicable for structures intended to be used offshore.
- (b) The fatigue assessment is to be performed on the gangway structure considering the cumulative damage effects of both the operational (including deployment/retrieval) and transit/parked cases and is to consider (but not limit to) the following gangway specifics:
- (i) Operation time: not less than 20 years.
 - (ii) Translation and/or rotation cycles in the directions/around X, Y and Z axis (e.g. telescoping, luffing, slewing, etc.).
 - (iii) Loads due to motion of the vessel on which the gangway is mounted.
 - (iv) Wind load may usually be excluded.
 - (v) Type I only: On and off-load cycles at full Live load (LL): not less than 6/day (e.g. 3 working shifts). The on and off-load cycles are to be agreed with the Society and be noted in the certificate.

Note:

1. On-load: gangway subject to full LL

CHAPTER 4 STRUCTURAL DESIGN AND STRENGTH

4.3 Strength Calculations

2. Off-load: gangway completely unloaded (LL=0)
 - (vi) Deployment/retrieval cycles/day.
 - (vii) The design fatigue factor (DFF) is not to be less than 2.
 - (viii) The load combinations for the fatigue assessment can be based on the load combinations defined in Table 4-4 and Table 4-5 below (as applicable).
 - (ix) Stress acceptance levels according to the fatigue standard used.
- (c) The stress range spectrum is to be defined by the designer considering the above minimum limitations.
- (d) Different fatigue design parameters are to be agreed with the Society on a case by case basis.
- (e) For gangway pedestal below the slewing ring, in addition to the above defined conditions, the introduction of relative stress in the pedestal caused by global deformation of the asset is also to be evaluated, if relevant.

Table 4-4
Type I Gangway - Load Combinations⁽⁴⁾

	LC 1a	LC 1b	LC 2a	LC 2b	LC 3	LC 4
	Normal working condition (see 4.2.2)	Normal working condition (see 4.2.2)	Deployment/retrieval (see 4.2.3)	Deployment/retrieval (see 4.2.3)	Emergency lift-off (see 4.2.4)	Parked/transit/survival (see 4.2.5)
Self-weight (SW) ⁽¹⁾	100%	$SW \times (g_0 + MOA)$	$100\% \times DF^{(2)}$	$g_0 \times DF + MOA^{(2)}$	$g_0 \times DF + MOA^{(2)}$	$g_0 + MTA$
Live load (LL)	LL = 400 kg/m ²	LL = 400 kg/m ² LL $\times (g_0 + MOA)$				
Live load (applied at the tip of gangway)					F \geq 600 kg F $\times (g_0 \times DF_Z + MOA)^{(2)}$	
Centrifugal force			100%, as applicable	100%, as applicable		
Green sea loads						100%, as applicable
Wind load		Operational wind speed		Deployment/retrieval wind speed	Deployment/retrieval wind speed	Parked/transit/survival wind speed
Acceptable criteria (see 4.3)	I	II	I	II	III	II ⁽³⁾

Notes:

- (1) SW includes gangway self-weight and all installed equipment.
- (2) Dynamic factor (DF_Z / DF_Y) due to vertical/horizontal loads due to operational motions.
- (3) Stresses in the gangway structure above the slewing bearing (e.g. in the bridge, etc.) may be accepted up to Load Case III allowable stresses, if extreme vessel accelerations (i.e. probability level 10⁻⁸) are used. If vessel accelerations with higher probability level (i.e. 10⁻⁴) are used, then stress levels are to comply with Load Case II safety requirements.
- (4) Other relevant load cases and/or combinations are to be agreed with the Society.
- (5) MOA – maximum operational accelerations, MTA – maximum transit/parked accelerations.

Table 4-5
Type II Gangway - Load Combinations^{(5),(6)}

		LC 1a	LC 1b	LC 1c	LC 2a	LC 2b	LC 3	LC 4	
		Normal working condition (see 4.2.2)			Deployment/ retrieval (see 4.2.3)	Deployment/ retrieval (see 4.2.3)	Emergency lift-off (see 4.2.4)	Parked/transit /survival (see 4.2.5)	
Self-weight (SW) ⁽¹⁾		100%	g ₀ +MOA	g ₀ +MOA	100% × DF ⁽²⁾	g ₀ ×DF+MOA ⁽²⁾		g ₀ + MTA	
Live load (LL)		LL	LL	min. 120 kg ⁽⁴⁾					
		2×LL	2×LL×(g ₀ +MOA)						
Live load (applied at the tip of gangway)									F ≥ 350 kg
									F×(g ₀ ×DF _Z + MOA) ⁽²⁾
Bumper loads	vertical:	100%, as applicable							
	longitudinal:								
	transverse:								
Centrifugal force							100%, as applicable		
Green sea loads							100%, as applicable		
Wind load					Operational wind speed	Operational wind speed	Deployment/ retrieval wind speed	Deployment/ retrieval wind speed	Parked/transit/ survival wind speed
Acceptable criteria (see 4.3)		I	II	II	I	II	III	II ⁽³⁾	

Notes:
(1) SW includes gangway self-weight and all installed equipment.
(2) Dynamic factor (DF_Z / DF_Y) due to vertical/horizontal loads due to operational motions.
(3) Stresses in the gangway structure above the slewing bearing (e.g. in the bridge, etc.) may be accepted up to Load Case III allowable stresses, if extreme vessel accelerations (i.e. probability level 10⁻⁸) are used. If vessel accelerations with higher probability level (i.e. 10⁻⁴) are used, then stress levels are to comply with Load Case II safety requirements.
(4) Gangway in uplift position (cantilever), load applied at the free end (tip).
(5) Other relevant load cases and/or combinations are to be agreed with the Society.
(6) Fully motion compensated gangways are to have special consideration; Not all load combinations and stress acceptance levels in the table are directly applicable.
(7) MOA – maximum operational accelerations, MTA – maximum transit/parked accelerations.

4.3.5 Design and strength of particular components

(a) General

The design and strength of particular components, such as slewing bearings, flanges, pedestals and pedestal adapters are to be based on the Rules for Cargo Gear or other recognized standards accepted by the Society.

(b) Wheel rolling on rail/structure

Calculation of stress is to be done according to applicable internationally recognized standards accepted by the Society (e.g. EN 13001-3-1 Annex C.4, EN 1993-6).

Alternatively, Finite Element calculations are to be provided.

(c) Hydraulic Cylinders

- (i) Requirements regarding cylinder wall thickness are described in Part VI, Table 2-3, 2-7 and 2-10 of the Rules for Steel Ships.
- (ii) Welds are normally to be full penetration welds. Other than full penetration welds may be accepted on a case by case basis provided that acceptable stresses (both with respect to fatigue and static) can be documented. This will primarily be applicable for cylinders used for pushing only.
- (iii) The design calculations for hydraulic cylinders are to be based on the maximum obtainable pressure (safety valve setting). Alternatively, if the maximum dynamic force applied on the gangway is known, this may be used as basis for the design calculations. In both cases different outreach positions are to be evaluated.
- (iv) Based on case by case considerations, a safety factor with respect to buckling down to 2.3 may be accepted for slenderness ratios above 110 when applying detailed calculations. For slenderness ratios below 90, buckling is not considered and a safety factor of 1.8 with respect to yield stress will be required. For slenderness ratios between 90 and 110, linear interpolation between the two above acceptance criteria is to be applied.
- (v) Other applicable internationally recognized standards may be used for designing various hydraulic cylinder details. These standards are to be agreed with the Society.

(d) Winches

For wire luffing gangways, the wire luffing winch is to be designed based on the Rules for Cargo Gear, 12.1(b) hoisting machinery or other recognized standards accepted by the Society.

4.4 Design Loads for Type I Gangways

4.4.1 Type I gangways are normally to be evaluated based on the Load Combinations (LC) defined in 4.2. Other design specific loads and load combinations are to be evaluated on a case-by-case basis.

4.4.2 Type I specific design requirements:

- (a) Normal working condition: Live load (LL) on the gangway 400 kg/m^2 .
 - (i) where live load is to be evenly distributed across the effective load area of the gangway and;
 - (ii) width of gangway for calculating the load is to be the clear width
 - (iii) length of loaded gangway is to be the maximum operational length without the safety length.
- (b) Emergency lift-off: Live load on the gangway tip 600 kg.

4.5 Design Loads for Type II Gangways

4.5.1 General

- (a) Type II gangways are normally to be evaluated based on the Load Combinations (LC) defined in 4.2. Other design specific loads and load combinations are to be evaluated on a case-by-case basis.
- (b) Type II specific design requirements are:
 - (i) Normal working condition:
 - (1) the gangway is to be designed according to the most onerous of the 2 below scenarios:
 - a) Live load on the gangway is to be the maximum number of persons, including hand tools/luggage, allowed on the gangway at the same time. The actual distribution of the LL

along the gangway (as specified in the gangway's operational manual) is to be used for calculations.

- b) Live load on the gangway tip 120 kg, gangway in uplift/cantilever position.
- (2) The design load is to be $2 \times$ live load.
- (3) Length of loaded gangway is the maximum operational length without the safety length.
- (4) Vertical and horizontal (longitudinal/transverse) bumper/push loads, as applicable.
- (ii) Emergency disconnection:
 - (1) Live Load on the gangway tip: minimum 350kg (equivalent to a minimum of 2 persons and a person in the stretcher).
 - (2) Gangway in uplift/cantilever position.
 - (3) Length of loaded gangway is the maximum operational length without the safety length.

4.5.2 Special consideration

- (a) Fully motion compensated gangways are to have special consideration.
- (b) As a general principle, these are to be designed according to the requirements in 4.5.1 with stress acceptance levels according to load case III (Accidental load case – when the motion compensating system is out of service).
- (c) In addition, the gangway is also to be calculated for LC 1a and LC 2a in para. 4.3.4/Table 4-5.

CHAPTER 5 FUNCTIONAL REQUIREMENTS

5.1 General

As a general rule, the gangway structure is to be designed so that the critical areas (joints, connections with the supporting structure, sliding surfaces and arrangements – wheels and rails, etc.) are to be easily accessible for regular inspection and maintenance.

5.2 Walking Height

Free walking height is to be a minimum of 2.1 meters.

5.3 Clear Width

Clear width is to be at least 1.2 meters for type I gangways and minimum 0.6 meters for type II gangways if not otherwise agreed with the Society.

5.4 Walkway

5.4.1 The surfaces of the walkway, treads and steps are to be of or coated with hard-wearing, oil resistant non-slip surface / coating.

5.4.2 Any features that could represent a tripping hazard for the persons crossing the gangway (e.g. pipe/cable guides, etc.) is to be avoided.

5.4.3 Toe boards not less than 100 mm high are to be fitted on either side of the walkway. Alternative arrangements are to be considered provided that they ensure at least the same safety and functional requirements.

5.4.4 The walkway is to be designed for drainage and easy cleaning of contaminants like mud and oil.

5.4.5 In case of open floorings (e.g. grating), the maximum size of the openings is to be evaluated taking into account the hazards caused by objects or other materials falling or passing through the flooring (e.g. injury to people working at lower levels, etc.).

5.5 Handrails

5.5.1 Handrails are to be in form of a protecting grid or railing, min. 1.0 m high on both sides:

- (a) Stanchions are to be spaced not more than 1.5 m apart.
- (b) Handrails are to have at least 3 courses. The openings below the lowest course of the handrails are not to exceed 230 mm. The other courses are to be not more than 380 mm apart.

5.5.2 These are to be designed for a side loading at the upper guide level of 75 kg/m (load case III).

5.5.3 Alternative arrangements are to be considered provided that the safety level achieved is similar or higher.

5.6 Access to Gangway and Waiting Area

5.6.1 The structural strength requirements of the waiting area and its access, as well as their connections with the gangway structure, are to be based on the below criteria.

5.6.2 If the gangway is designed with a personnel waiting area attached to or otherwise supported by the gangway, the design load for this area is to be 400 kg/m². The design loads for the waiting area are to be considered when evaluating the strength of the main structure of the gangway.

5.6.3 The access to the gangway and/or waiting area (in form of a stairway, a dedicated small gangway/ramp or the gangway itself) is to be designed for a load not less than 400 kg/m² (but not less than 100 kg applied in the most onerous position) or 100 kg/step applied as a central point load on every step.

5.6.4 The handrails are to be able to withstand an impact force of 50 kg/m at the upper level without permanent deformation.

Note:

1. It is recommended that the design of the access to the gangway and waiting area, in terms of dimensional and layout requirements, complies with international recognized standards/codes.
2. It is recommended that the access to/from the gangway to be ensured by means other than ladders.

5.6.5 In addition to the above, access (including any stairs at either or both ends) to the gangway is to be according to SOLAS, flag state, shelf state and class requirements.

5.7 Protecting Grid

5.7.1 There is to be adequate protection at locations of relative movement between gangway sections to prevent injury to parts of the human body. These are to be highlighted and marked using high visibility paint.

5.7.2 The minimum size of the gaps below which the hazard of crushing parts of the human body is considered acceptable is to be calculated based on an internationally recognized standard.

5.8 Lighting

Satisfactory lighting is to be arranged for the entire gangway (including the access to gangway, see 5.6) and landing platform with stairs, etc. Average illuminance at floor level is to be not less than 100 lux. Illuminance at locations of relative movement between gangway sections, as well as at the ends of the gangway are to be of not less than 300 lux at floor level.

5.9 Landing Area

5.9.1 Gangway supported at both ends

- (a) For gangways supported at both ends in X, Y, and/or Z axis directions, the landing area is to be arranged to prevent unacceptable movement. This may include a platform for providing support in Z axis direction, side stoppers or equivalent arrangements to prevent unacceptable sideways movements.

CHAPTER 5 FUNCTIONAL REQUIREMENTS

5.10 Operation Angle

Other arrangements are to be agreed with the Society.

Note:

'Side stopper' may be a physical structure or lashing.

- (b) Design features to prevent unacceptable movement (e.g. platform, side stoppers, etc.) are to be dimensioned for a design load of twice the resultant loads in X, Y, and Z axis directions at the gangway tip due to:
 - (i) gangway self-weight and live loads
 - (ii) loads due to climatic effects, see 4.1.5
 - (iii) loads due to motion of the vessel on which the gangway is mounted/supported, see 4.1.6.
- (c) The gangway is to be fitted with a break-away system, see 6.7.

5.9.2 Gangway supported at one end only (cantilever)

- (a) For gangway designed to operate as a cantilever, the gangway is to be equipped with a system to hold the gangway end in constant position in X, Y and Z axis directions. Tolerance is not to be more than ± 100 mm unless suitable protection to prevent personal injury is installed.
- (b) The function is not to be affected by loss of main/normal power: the functionality is to be ensured through redundancy in the power feeds and HPU pumps.
- (c) In addition, the gangway is to be designed for an upward vertical load and horizontal loads (in direction of X and Y axis) according to 4.5 (as applicable). See also 6.10.1.

5.9.3 Gangway supported at both ends (gangway tip in light contact with supporting structure)

- (a) For such gangways, the provisions in subsections 5.9.1 and 5.9.2 are to be followed, as applicable.

5.10 Operation Angle

5.10.1 General

- (a) Normally, a gangway is classified as a ramp. The maximum operational angle to the horizontal for the gangway is to be ± 10 degrees. Up to ± 20 degrees may be used if the gangway is fitted with enhanced slip resistance features.

Note:

Steeper operational angles may be considered provided that the deck of the gangway is fitted with treads or steps. This is to be agreed with the Society.

5.10.2 Tread design

- (a) All treads are to be securely fitted, and are to extend over the full width of the gangway between the toe boards. Provision is to be made for easy cleaning of the gangway between the treads, by leaving a 25 mm space between tread and toe board at each side. Liquids are to not gather between the treads.
 - (i) spacing: at regular intervals, not more than 400 mm (in X axis direction)
 - (ii) height: not less than 30 mm above the walkway.

5.11 Power System

5.11.1 The main gangway functions (slewing, luffing and telescoping) is to have such response to the controls that the minimum required speed from stand still is to be obtained within 2 seconds from activation of the control lever. The control levers are to have predictable smooth motions proportional to their position.

5.11.2 The gangway is to have enough power to be able to perform its functions (slewing, luffing and telescoping) with adequate speed, thus enabling it to connect/maintain its position relative to the landing area in a safe and quick manner.

5.12 Electrical Installations, Equipment and Systems

5.12.1 Electrical installation is to comply with relevant and recognized codes or standards pertinent to the location of the gangway.

5.12.2 Electrical installations of gangways certified by the Society are to comply with Part VII, Electrical installations of the Rules for Steel Ships. However, the documentation requirements are still to be taken from 2.1.1. Further, the certification requirements are still to be taken from 2.2.1.

5.12.3 The electrical equipment and systems supporting the gangway main functions are to comply with the Rules for Steel Ships, Part VII, Electrical installations and will generically be defined as "essential". Specific equipment and systems having impact on the Safety and safety equipment requirements listed in Chapter 6 are to fulfil requirements with respect to essential installations.

5.13 Hydraulic Systems

5.13.1 General

- (a) Hydraulic systems and their lay-out are to satisfy recognized codes or standards and engineering principles and are to, as far as relevant or applicable, comply with pertinent rules of the Society.
- (b) When designing hydraulic circuits, all aspects of possible methods of failure (including control supply failure) are to be considered. In each case, components are to be selected, applied, mounted and adjusted so that in the event of a failure, maximum safety to personnel is to be the prime consideration, and damage to equipment minimized. (fail-safe concept)
- (c) All parts of the system are to be designed or otherwise protected against pressures exceeding the maximum working pressure of a system or any part of the system or the rated pressure of any specific component.
- (d) Systems are to be designed, constructed and adjusted to minimize surge pressures and intensification pressures. Surge pressure and intensified pressure is to cause no hazards.
- (e) Loss of pressure or critical drops in pressure as well as missing hydraulic refilling aren't to cause a hazard.
- (f) Leakage (internal or external) is not to cause a hazard.
- (g) Whatever type of control or power supply used (e.g., electrical, hydraulic, etc.), the following actions or occurrences (unexpected or by intention) are to create no hazard:

CHAPTER 5 FUNCTIONAL REQUIREMENTS

5.13 Hydraulic Systems

- (i) switching the supply on or off
 - (ii) supply reduction
 - (iii) supply cut-off or re-establishment.
- (h) Hydraulic systems and other machinery in connection with the hydraulic system are to be designed to protect personnel from surface temperatures that exceed touchable limits by either insulating or guarding.
- (i) To facilitate maintenance, means are to be provided or components so fitted that their removal from the system for maintenance:
 - (i) are to minimize the loss of fluid
 - (ii) are not to require draining of the reservoir
 - (iii) are not to necessitate extensive disassembly of adjacent parts.
- (j) The fluid reservoir is to be designed with respect to:
 - (i) dissipation of heat from the oil
 - (ii) separation of air
 - (iii) settling of contamination in the oil
 - (iv) maintenance work.
- (k) Indicators showing the fluid level are to be permanently marked with system “high” and “low” levels.
- (l) Air breathers on vented reservoirs are to be provided which filter air entering the reservoir to a cleanliness level compatible with the system requirements, taking into consideration the environmental conditions in which the system is to be installed.
- (m) Effective means for filtration and cooling of the fluid are to be incorporated in the system.
- (n) A means of obtaining a representative fluid sample is to be provided to allow for checking fluid cleanliness condition.
- (o) Valves for fluid sampling are to be provided with sealing and with warning signs marked “system under pressure”.

5.13.2 Flexible hoses

- (a) Flexible hoses and couplings are to be of approved type (type approval certificate issued by the Society is recommended).
- (b) Flexible hoses are to only be used:
 - (i) between moving elements
 - (ii) to facilitate the interchange of alternative equipment
 - (iii) to reduce mechanical vibration and/or noise.
- (c) Flexible hoses are to be located or protected to minimize abrasive rubbing of the hose cover.

5.13.3 Accumulators

Accumulators are to be separately approved.

5.13.4 Hydraulic cylinders

- (a) Load carrying hydraulic cylinders (e.g. luffing cylinders, etc.) are to be separately approved in accordance with relevant requirements of the Rules for Steel Ships or a recognized standard.
- (b) Materials for hydraulic cylinders are to fulfil the requirements in Part XI of the Rules for Steel Ships, or a recognized standard.
- (c) Specific design requirements for hydraulic cylinders to be installed on offshore gangways are listed in 4.3.5(c).

5.13.5 Testing

- (a) Except for mountings, each component is to be pressure tested to 1.3 times the design pressure, but not more than 70 bars above the design pressure.
- (b) Hydraulic testing of the assembly is to be performed in the presence of the Surveyor, unless otherwise agreed. The pressure from the overload testing is deemed sufficient and is to be maintained for a time sufficient for check of leakage. The assembly is to exhibit no sign of defects or leakage.

5.14 Pneumatic Systems

5.14.1 Pneumatic systems

- (a) Air intakes for compressors are to be so located as to minimize the intake of oil- or water-contaminated air.
- (b) When designing pneumatic circuits, all aspects of possible methods of failure (including control supply failure) are to be considered. In each case, components are to be selected, applied, mounted and adjusted so that in the event of a failure, maximum safety to personnel is to be the prime consideration, and damage to equipment minimized. (fail-safe concept.)
- (c) Loss of pressure or critical drops in pressure is to cause no hazard.
- (d) Leakage (internal or external) is to create no hazard.
- (e) Whatever type of control or power supply used, the following actions or occurrences (unexpected or by intention) are not to create a hazard:
 - (i) switching the supply on or off
 - (ii) supply reduction
 - (iii) supply cut-off or re-establishment.
- (f) Air supply to instrumentation equipment is to be free from oil, moisture and other contaminants. The dew point is to be below 5°C for air in pipes located in gangway engine room. In pipes outside the engine room the air is to have a dew point below (Design temperature T_D - 5)°C.
- (g) Components requiring extremely clean air are not to be used.

- (h) Main pipes are to be inclined relative to the horizontal, and drainages are to be arranged.
- (i) Piping and pressure vessels are to comply with relevant recognized codes and are generally to comply with Part V and Part VI of the Rules for Steel Ships.

5.15 Control and Monitoring Systems
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5.15.1 General

- (a) Control and monitoring systems components and installations are to comply with Part VIII of the Rules for Steel Ships, or other recognized standards accepted by the Society.
- (b) Control and monitoring systems supporting the gangway main functions are generically defined as essential according to Part VIII of the Rules for Steel Ships. Specific equipment and systems having impact on the Safety and safety equipment requirements listed in Chapter 6 of the Guidelines are to fulfil requirements with respect to essential installations.

5.15.2 Wireless remote control systems

- (a) Wireless remote control systems are to be specially considered and the requirements are agreed with the Society.

- (b) Guidance for safety and functionality requirements can be found below:

Note:

- (i) The principles for wireless remote control are to be:
 - (1) Safe state for the gangway and for the wireless remote control operation is to be defined. In general, all over systems are to have a defined fail-safe mode. This means that all outputs returns to normal mode (normally open/normally closed depending of type of output) in case of an emergency stop situation, loss of signal, loss of power-supply or other defined failure modes. Wiring diagram and test reports for all inputs/outputs are delivered with each system.
 - (2) Normally it will assume that safe state is immediate stop of all gangway movements. The gangway brake capacities are to be sufficient to hold the gangway and the live load at any position within a given response time.
(Some gangways are equipped with motion compensation, automatic overload protections, emergency operation, etc. In such cases safe state may not be complete stop). The reaction of the complete system (gangway) related to a stop-situation will depend of the functionality of the connection of the remote control system, and is the responsibility of the gangway-builder.
 - (3) Furthermore:
 - a) The system is to prevent operation if the operator leaves the normal operating area for the gangway. Prevention of this has to be implemented by the gangway-builder
 - b) The data sent to/from the remote control unit are to be subjected to error detection and/or error correction.
 - c) Transmitting of radio data is also to be made possible by “handshaking”.
- (ii) The wireless communication with the gangway is not to be disturbed by any other external communication signals, and it is to be designed in accordance with accepted standards for emission. Radio solutions are to be tested in accordance with international recognized standards/codes (e.g. ETSI EN 301 489 Electromagnetic compatibility and Radio spectrum Matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services etc.).
- (iii) If it cannot be proven that the frequencies allocated for the wireless communication for a specific gangway are unique in all areas where the gangway will be operated, and that such communication

will never be interrupted by external communication signals, some kind of unique encryption or ID of the wireless communication or similar is strongly recommended.

The main concern is that such arrangements are to prevent other signals from controlling the gangway movements.

- (iv) Loss of communication with the unique remote control is to cause the gangway to go into a safe state as outlined in item (i) above.
- (v) Additionally, an emergency stop independent of the wireless remote control is to be installed.
*Responsibility of the gangway-builder.

Furthermore:

- (1) By starting of the remote control unit a self-check is to be conducted in order to prevent movements if the control has been left in such mode.
- (2) The gangway is also to be provided with a hardwired emergency stop easily accessible.
*Responsibility of the gangway-builder.
- (3) The remote control unit is to be provided with a key-switch for closing when not in use.
- (4) The remote control unit is also to be provided with a “dead man button”.
- (vi) The planned operation is to be subjected to an analysis where special hazards and risks are identified. For high-risk operations caused by mal-operation or equipment failure, the risk and the safety measures are to be documented in a detailed analysis (see 6.13).
*Responsibility of the gangway-builder.

5.16 Motion Compensating System

5.16.1 Should a gangway be fitted with an active motion compensating system, then it is to fulfill the following requirements:

- (a) Components and installations of the motion compensating system are to comply as a minimum with Part VIII of the Rules for Steel Ships, where applicable. The motion compensating system is to be generically defined as "essential", see Part IV, 1.3 of the Rules for Steel Ships,.
- (b) Additional certification requirements, as per Table 2-3, are to be applicable.
- (c) Activation of any system with any particular load is to not lead to a hazardous situation.
- (d) No single failure is to lead to a hazardous situation.
- (e) Any failure/fault is to give an alarm at the control station.

CHAPTER 6 SAFETY AND SAFETY EQUIPMENT

6.1 General

6.1.1 All gangways are to be provided with safety functions, reducing the risk connected to personnel transfer operations. The subsequent safety function requirements are founded on a risk based approach. It is up to the customer to select the technological platform for the safety functions. In principle, all alternatives providing equivalent safe operation will be accepted.

6.1.2 A series of systems preventing the use of the gangway outside its operational limitations are to be installed (e.g. overload systems, break-away system, automatic release, etc.).

6.2 Parking and Precautions Against Wind Loads

Means to secure the gangway in “an out of service condition” in a safe manner are to be provided. The effect of wind and wind gusts in addition to vessel motions is to be considered.

6.3 Protection and Precautions Against Fire

6.3.1 Fire/fire ignition may arise from the gangway itself or from the ship/installation, and thereby lead to disaster. Necessary protection and precautions against fires and explosions are to be considered in each case, with consideration to the hazardous area classification in which the gangway or parts of the gangway will operate and to the requirements to the gangway’s emergency preparedness.

6.3.2 The number, capacity and location of fire extinguishers and/or automatic fire fighting system are to be adequate for the type of gangway and its intended service. However, at least one fire extinguisher is to be provided in the operator's cabin.

6.3.3 Air pipes from fuel tanks are to be led to open air. Drip trays are to be arranged at fuel filling pipe.

6.3.4 It is to be possible to stop/close the following components from a central place outside the gangway engine room:

- (a) valves on tanks for flammable fluids
- (b) pumps for flammable fluids
- (c) flaps (shutters) in air ducts to engine room
- (d) fans for ventilation
- (e) engines.

6.4 Operator's Cabin

6.4.1 If required or fitted, the cabin is to satisfy the following overall requirements:

- (a) be of adequate size and give adequate protection against weather and other environmental exposure
- (b) give the operator an adequate view of the area of operation
- (c) have windows capable of being readily and safely cleaned inside and outside and to have defrosting and defogging means, is to have windscreen wipers fitted to all windows necessary for the gangway operator's free view when operating the gangway
- (d) be adequately tempered (heated, cooled) and ventilated according to local conditions
- (e) be of fireproof construction, have doors that can be readily opened from both inside and outside
- (f) noise and vibration are to remain within acceptable limits

Note:

It is recommended that noise level is kept under 80 dB inside the cabin.

- (g) have a comfortable and purpose-designed seat from which all operations can easily be controlled. Foot rests are to be arranged where necessary
- (h) have the gangway controls marked and lit to show their respective function.

Note:

It is recommended that the design complies with international recognized standard/code (e.g. EN-13557).

- (i) Gangways are to be arranged with emergency escape in addition to the main access. Portable escape equipment may be accepted.

6.5 Operator in Control

6.5.1 The operator are to have the possibility to manually override any of the gangway's automatic safety systems in case of an emergency.

6.5.2 Type II gangways are to be designed such that they can be used only with an operator present in the control cabin/pod at all times.

6.6 Single Fault

6.6.1 The support and suspension system for the gangway in lifted/operational position is to be so constructed that no single fault can cause the gangway tip to fall or drop suddenly.

6.6.2 The motion compensation system, slewing and telescopic systems are to be so constructed that no single fault can affect their functionality.

6.7 Break-away System

6.7.1 The connection of the gangway tip to the landing platform/area/support structure is to have a suitable break-away system to allow the gangway to be easily disconnected from the supporting structure.

6.7.2 The system is to be designed for a break-away force of no more than 30% higher than the horizontal resultant loads due to climatic effects (e.g. wind), longitudinal push/pull force and vessel motions.

6.7.3 In addition, arrangement for automatic release from the attached unit in case of an emergency release (when triggered by the operator – see 6.9, or by the automatic protection system – see 6.8) is to be made.

6.7.4 The function is not to be affected by loss of main electric power.

6.8 Automatic Protection System (APS)

6.8.1 When the gangway control system detects a pre-defined automatic break-away condition (e.g. overloading 6.10.1, gangway movements outside operational limitations 6.10.2, loss of support landing area 6.10.9, etc.) it is to automatically provide warning by audible and visual means for the users before it detaches, lifts and/or retracts and/or slews to a pre-defined safe position.

6.8.2 The APS is to be configured such that it will allow any persons crossing the gangway when the acoustic and visual alarms are triggered to get to a safe zone prior to initiation of movement on any of the X, Y and Z axis directions.

6.8.3 Emergency slewing will be required where slewing is necessary to obtain a safe position.

6.8.4 After repositioning of the bridge to a safe position, it is to be possible to reset the function and resume normal operation.

6.8.5 The function of APS is not to be affected by loss of main/normal power.

6.8.6 In the event of APS activation, an alarm is to be given in a manned control room, local control cabin/pod and vessel Integrated Automation System (IAS).

6.8.7 For permanently manned gangways (i.e. the operator is actively controlling and supervising the entire personnel transfer operation: gangway deployment – personnel transfers – gangway retrieval), APS needs not to be installed.

6.8.8 When not installed, all the information otherwise collected from the sensors monitoring the risk contributors listed in 6.10 is to be displayed at the operator's control pod/station. Consequently, the operator will decide what actions are to be undertaken.

6.9 Manual Protection System (MPS)

6.9.1 A manual protection system is to be fitted on the gangway to enable the operator to disconnect the gangway in case of an emergency (e.g. generated by one or a combination of multiple risk contributors, see 6.10). When activated, the system is to automatically provide warning by audible and visual means for the users before it detaches, lifts, retracts and slews to a pre-defined safe position, whilst remaining safe for any personnel on it.

6.9.2 Emergency slewing will be required where slewing is necessary to obtain a safe position.

6.9.3 The MPS is to operate under all conditions, including failure in the main power supply and failure in the control system, and is to override all other functions when activated. The system is to be arranged for manual activation. The activation switch or handle is to be located for rapid access at the control station, permanently marked with yellow color, and protected against inadvertent use.

6.9.4 At any time, the system is to be able to be reset by the gangway operator, without causing damage to the gangway.

6.10 Generic Risk Contributors

6.10.1 Overloading

Overloading may lead to gangway structure collapse. The below listed systems are to be connected to the gangway alarm and protection system(s) (see 6.8 and 6.12).

(a) Automatic lateral overload protection

Automatic lateral overload protection is to be provided on the slew mechanism to prevent overload if side load exceeds the design limits.

(b) Automatic vertical overload protection

Automatic vertical overload protection is to be provided for gangways designed to be operated as cantilevers to prevent overload if the upward vertical load exceeds the design limits.

(c) Automatic axial overload protection

Automatic axial overload protection (in gangway X axis direction, along the gangway) is to be provided on the telescoping system to prevent overload if the axial load exceeds the design limits.

6.10.2 Gangway movements outside operational limitations

(a) General

- (i) Gangway movements outside operational limits may lead to stress beyond the gangway's structural strength and to operational hazards.
- (ii) All gangway movements are therefore to be kept within safe operational limitations, either by means of limit devices/alarms or physical layout.
- (iii) The luffing winches are to be equipped with upper and lower limiters, stopping the winch movements within safe margins to avoid collision with other structures and keeping safe number of retaining wire rope turns on the drum - usually minimum three.
- (iv) Special consideration is to be paid to the gangway's bridge upper limit protection for wire rope suspended bridges, where redundancy by means of two independent limit devices is required.
- (v) Limit devices are to be positively activated and be of failsafe type, i.e. the gangway is to go to a defined safe condition in case of failure (power failure, etc.). Activation of limit devices is to lead to indication in the gangway operator's cabin. After activation of a limit device, movement in the reverse direction - to a more safe position - is not to be prevented. Where more than one movement causes over-travel, all limit devices limiting such over-travel are to be activated simultaneously (e.g. telescope over-travel may be caused either by slewing or luffing). A manually operated over-ride system, provided positive and maintained action combined with indication and alarm, may be fitted.

(b) Safety length

- (i) For telescopic gangways, the length of the gangway and the arrangement are to be such that there is a minimum of $[1+(L-20)/50]$ m, but not less than 1 m, movement reserve in each direction beyond the maximum movement of the gangway in relation to the landing area during operation.

Note:

L = gangway length at maximum operational stroke/extension (m)

- (ii) When the maximum operational length of the gangway is reached, the gangway is to be automatically brought to a safe state (see 6.8).

(c) Safety angle

The gangway is to be designed to remain operational for a range of luffing angles exceeding the operational angle by not more ± 5 degrees. When outside the operating range, the gangway is to be automatically brought to a safe state (see 6.8).

6.10.3 Dangerous gangway movements

- (a) Dangerous gangway movements or unintentional gangway movements due to malfunction in the gangway's control system may lead to operational risks.
- (b) A manually operated emergency stop function, leading to shut-down and stop of the gangway movements, is to therefore be fitted. Simultaneously, the brakes are to be engaged in a progressive and safe manner. The emergency stop is to retain its function regardless of any malfunction in the gangway's control system. Emergency stop actuators are to be located at convenient locations at control station for immediate use by personnel in the event of a hazardous situation occurring.
- (c) The emergency stop is to function as, or stopping by:
 - (i) immediate removal of power to the machine actuators, or
 - (ii) mechanical disconnection (declutching) between the hazardous elements and their machine actuators.
- (d) The emergency stop is to be so designed that deciding to actuate the emergency stop actuator is not to require the operator to consider the resultant effects (stopping zone, deceleration rate, etc.). The emergency stop command is to over-ride all other commands except the MPS (see 6.9). The emergency stop function is not to impair the effectiveness of the safety devices or devices with safety related functions. Resetting the control device is only to be possible as the result of a manual action on the control device itself. Resetting the control device is not to cause a restart command.
- (e) The emergency stop actuators are to be designed for easy actuation. Types of actuators that may be used include:
 - (i) mushroom type push button
 - (ii) wires, ropes, bars
 - (iii) handles
 - (iv) in specific applications, foot pedals without protective cover.
- (f) Measures against inadvertent operation are not to impair the accessibility of the emergency stop actuator. The emergency stop actuator is to be coloured red. The background is to be coloured yellow, as far as practicable. If the emergency stop actuator is not located directly on the machine, labels are to be provided addressing the actuator to the machine. A warning/alarm and an indication in the gangway cabin/on the operator control pod is to inform the gangway operator that the emergency stop has been activated.

6.10.4 Lack of visibility

- (a) Lack of visibility due to poor sight or due to gangway operations in the gangway operator's blind zone may lead to operational hazards (e.g. during deployment).
- (b) Consequently, a camera installed at the free end of the gangway is recommended for all gangways associated with personnel transfers to/from floating assets. The camera and camera installation are to be designed with due consideration to environmental factors (wind, salt, moisture, vibrations, etc.) and operational suitability.

6.10.5 Lack of communication

- (a) Lack of communication between the gangway operator and the other participants in the gangway operation may lead to operational hazards.
- (b) Two-way communication equipment, enabling the gangway operator to communicate with the participants in the gangway operation in a safe way, is to be provided. The gangway operator is to be able to operate the communication system without moving his hands from the main control levers/pod.

6.10.6 Failure in control system

- (a) Failure in the gangway's control system may result in unintentional gangway response and movements.
- (b) Control system design and components are to therefore be selected, applied, mounted and adjusted so that in the event of a failure, maximum safety is to be the prime consideration (fail-safe concept). All aspects of possible methods of failure (including power supply failure) are to be considered. If any failure occurs, the control system is to always return to the predefined safest condition. Special consideration is to be paid to the below points if subjected to failure in the control system:
 - (i) unintended start of machinery is not to be possible
 - (ii) safety devices or devices with safety related functions are to be impaired to a minimum degree.
- (c) An alarm and an indicator revealing any detectable failure in the control system affecting the operation is to be present in the gangway cabin/control pod.

6.10.7 Failure in safety components/system

- (a) Failure in safety components and the safety system may result in hazardous situations due to override of safety limits.

The safety components/system are to therefore be so designed that all aspects of failure (including power supply failure) are to lead to indication and alarm in the gangway cabin (monitoring), or – alternatively – safeguarded by redundancy design.

6.10.8 Lack of holding/braking capacity

- (a) Wire luffing gangways

Insufficient braking/holding capacity may lead to uncontrolled gangway movements (falling bridge, etc.). All driving mechanisms and winches intended for luffing are to be fitted with fail-safe brakes, i.e. failure of the brake's control system is to normally lead to automatic application of the brake.
- (b) Cylinder luffing gangways

Lack of load holding capacity due to missing hydraulic refilling or loss/drop of hydraulic pressure, may lead to falling bridge.

The gangway's hydraulic system is to therefore be designed such a way that missing hydraulic refilling is not to occur. Further, the hydraulic system is to be fitted with safety or load holding valves on all main circuits protecting against unintended movements in case of hose rupture.

6.10.9 Loss of support landing area

- (a) The gangway is to be automatically brought to a safe state if it should lose the support at its tip (see 6.8).
- (b) The loss of support in the landing area is not to cause a sudden drop or fall of the gangway tip.
- (c) The function is not to be affected by loss of main/normal power.

6.10.10 Loss of power

- (a) Blackout/shutdown may lead to gangway stopping in an unfavorable and unsafe position.
- (b) A loss of electric power is not to lead to the gangway becoming inoperable. In the event of loss of main/normal power an alarm is to be given in a manned control room, local control cabin/pod and vessel Integrated Automation System (IAS).
- (c) The gangway is to be connected to an independent emergency power supply, rated to handle the gangway at full Live Load (LL), i.e. luffing, slewing, telescoping and full functionality under all conditions. The emergency power supply may be a redundant main power supply or an emergency power supply from the installation, or a stand-alone emergency power supply in the gangway. The activation switches or handles for emergency operation is to be of "hold to run" type and clearly and permanently marked for their purpose.

6.10.11 Unintended activation of safety functions

- (a) Unintended activation of safety functions may lead to gangway response giving unintentional hazards/risks.
- (b) Handling devices for safety functions are to be protected against inadvertent use and positioned away from ordinary operating handles. Interlock devices, preventing inadvertent activation in dangerous zones (water zone only, etc.) are to be fitted when possible.

6.10.12 Spurious trip of safety functions

- (a) Initiation of a safety functions in no-hazardous situations and where there is no true demand for safety activation due to safety or control system failure, may cause other types of hazards/risks.
- (b) Consideration to spurious trip is to be taken in the design of the safety and control systems. A risk assessment may be required for identification and possible elimination/reduction of spurious trip and corresponding hazards/risks (see 6.10).

6.10.13 Hazards due to activation of safety functions

- (a) Activation of safety functions may lead to secondary effects that may be harmful to the gangway and/or the persons operating/crossing it.
- (b) Design of safety systems and components is to be done with consideration to dangerous secondary effects.
- (c) Sector limitations for some safety functions are to be considered.

6.11 Monitoring

6.11.1 Wind speed, vessel acceleration and gangway movement including telescoping distance, slewing and luffing angle are to be constantly recorded, displayed and monitored by the gangway operator at a manned control room and/or at the unit's local control pod/cabin. This is to be logged into the system database.

6.11.2 Audible and visual alarms are to be incorporated in the display system to alert control persons when the wind, vessel and/or Gangway motions go outside pre-defined Operational values.

6.12 Alarm

6.12.1 An alarm system comprising of visual and acoustic warning devices is to be integrated with the gangway control and monitoring system and connected to a manned control room or vessel Integrated Automation System (IAS).

6.12.2 It is to be installed in various locations along and in the proximity of the gangway.

6.12.3 The alarm system is to be structured into different levels, depending on the importance of the risk it signals. Below are listed 3 possible alarm levels and suggested warning signals list as follows:

- (a) For normal personnel transferring operations, there is to be a clearly visible traffic light (Red/Green) and sound signal on each end of the gangway informing the user when it is safe or not to enter the gangway. The traffic light at the gangway tip is also to inform personnel on the gangway when it is safe or not to exit the gangway.
- (b) A clearly visible warning alarm comprising of yellow light and strong acoustic signals are to inform users that the gangway is not yet/anymore safe to be used when:
 - (i) gangway movements are likely to become dangerous (e.g. gangway losing its support, exceeding its operating limits, gangway movements during deployment, retrieval and parking, etc.);
 - (ii) environmental conditions (e.g. wind speed, vessel accelerations, etc.) escalate to values outside the operating envelope of the gangway;
 - (iii) the overload limit (on either of X, Y and Z axis directions) is about to be exceeded (e.g. at 90% of the overload limit).
- (c) When the gangway control system detects a pre-defined automatic lift-off condition, in case of a technical or system failure, power loss or any other event that was defined as a major risk in the gangway operational manual, a flashing Red light and stronger acoustic signals are to inform the users that the gangway is no longer safe to use.

6.12.4 The visual and acoustic signals are to be unique to the gangway system, so that they cannot be confused with the supporting vessel alarm system.

6.12.5 Cancellation of any triggered alarm is to be manual, only from the gangway control pod/cabin.

6.13 Failure Mode Effects Analysis/Failure Mode Effects and Critically Analysis

6.13.1 In addition to the documentation requirements as specified in Chapter 2, a Failure Mode Effects (and Critically) Analysis (FME(C)A) of the installed gangway system is to be performed to demonstrate that the gangway is safe to use.

6.13.2 For more complex gangway systems (e.g. fully motion compensated gangways, gangways with a high degree of automation with respect to safety functions, etc.), the functional safety of the electrical/electronic/programmable electronic safety-related systems are to be evaluated based on an internationally recognized standard (e.g. IEC 61508).

6.14 Ranking of the Safety Functions

The Manual Protection System (MPS) and the emergency stop function are to be the preferred safety functions and have equal priority, before other safety functions/devices/limiters. As specified in Table 6-1 below.

Table 6-1
Monitoring of Safety Functions

Event	Ref.	Indication	Alarm	Auto protect (6.8)
Overloading	6.10.1	×	×	×
Movements outside operational limitations	6.10.2	×	×	×
Emergency stop	6.10.3	×	×	×
Failure in control system	6.10.6	×	×	
Failure in safety system	6.10.7	×	×	
Loss of support landing area	6.10.9	×	×	×
Loss of power	6.10.10		×	×
Fire/gas	6.3		×	×

6.15 Handling of Deviations and Extended Risks

6.15.1 In cases where the risk deviates from the generic by means of:

- (a) assumed maximum consequence for one hazard/risk contributor that will exceeds one fatality (with the exception of “fire/fire ignition”), or where the specific risk contributors deviates from the specification in 6.10, identification of the specific risk and risk contributors is the customer’s responsibility and is to be shown in the submitted documentation.

6.15.2 Further, when the specific safety functions deviates from the generic as specified in 6.10, this is to be agreed with the Society.

CHAPTER 7 TESTING AND MARKING

7.1 Functional Testing of Completed Gangways

7.1.1 General

- (a) Before being put into service for the first time, each completed gangway is to be thoroughly tested to confirm that all the safety, power and control functions are correctly implemented onboard.
- (b) If complete functional testing has been documented to have been carried out at the test bed at manufacturers' location, limited functional testing may be carried out after final installation.
- (c) In such case, the proposed test plan is to specify the extent of the limited functional testing to be done after final installation. (see also 2.2.3 Note)
- (d) The functional testing is to be carried out in accordance with the approved testing procedure, which is to be submitted well in advance of the actual testing. The testing procedure is to specify in detail how the respective functions are to be tested and how observations during the test can be ensured. The tests specified below is to be included in the test procedure.
- (e) A copy of the approved test procedure is to be kept in the gangway (operational) manual. It is to be completed with final results and endorsed by the competent person.
- (f) The significant characteristics of power and braking systems as well as the safety equipment are to be considered. Braking systems and safety equipment are to be checked by function testing. Pressure testing of hydraulic components is normally not required to be witnessed by the Surveyor. The tightness of the systems is to be checked after the installation of the components and during functional testing.
- (g) For gangways fitted with systems not included in the below list (e.g. motion compensation system, etc.), additional relevant tests are to be agreed with the Society.
- (h) Load and functional testing is to be repeated every 5 years.
- (i) In addition, functional testing is to be performed regularly, see Appendix A.

7.1.2 Prime movers and fluid power systems

- (a) Relevant parameters such as power, ambient temperature and pressure, exhaust gas temperature etc. are to be measured and recorded.
- (b) Automatic control, remote control and alarm systems connected with power systems are to be tested.
- (c) After the test, the lubricating and/or hydraulic oil filters are to be checked for solid particles. Other components of machinery may be required opened up by the Surveyor.

7.1.3 Governing and monitoring systems

- (a) It is to be verified that control systems function satisfactorily during normal load changes.
- (b) Failure conditions or boundary conditions are to be simulated as realistically as possible, preferably letting the monitored parameters pass the alarm safety limits.

7.1.4 Electrical installations

- (a) Insulation resistance test is to comply with the requirements in 3.8.2 of Part VII of the Rules for Steel Ships.
- (b) When found necessary by the Surveyor, switchgear is to be tested on load to verify its suitability and that operating of over-current release and other protective measures are satisfactory. Short circuit tests in order to verify the selectivity may also be required.

7.1.5 Brakes

- (a) Brakes are to be tested by braking each motion from maximum speed to full stop. In addition, each brake for the luffing motion is to be tested for three such stops in quick succession during lowering motion.
- (b) The emergency stop system is to be tested. The test may be carried out at reduced speed and with reduced load.

7.1.6 Safety equipment

Safety functions as presented in para. 6.14/ Table 6-1 as well as the specific safety function requirements as given in the respective discipline sections are to be tested.

7.2 Factory Testing

7.2.1 General

- (a) Before a gangway is put into service, the following is to be carried out.
- (b) The tests are not to cause permanent deformation and the gangway is not to be brought into such a position that it represents danger to persons on the gangway.
- (c) All tests are to be held for minimum 15 minutes.
- (d) Testing is to be performed according to an approved test procedure.

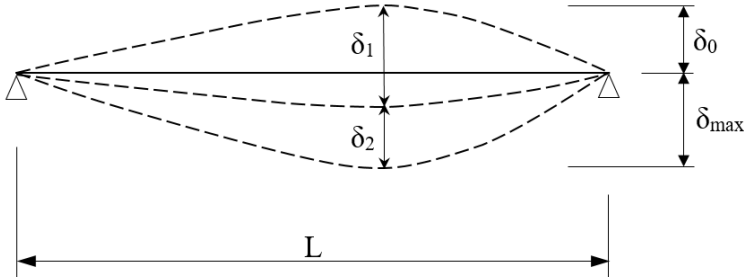
7.2.2 Bridge load test

- (a) Type I
 - (i) With the gangway extended to its maximum operational length (L) and supported at both ends, a load test equal to 500 kg/m² is to be applied along the gangway.
 - (ii) The total structural deflection of the gangway is not to exceed L/200. The test is not to cause permanent deformation.
- (b) Type II

- (i) For gangways designed to operate while supported in Z-axis direction at both ends, with the gangway extended to its maximum operational length, a load test equal to $1.25 \times LL$ (live load), but not less than 300 kg, is to be applied at the middle of the gangway.
- (ii) For gangways designed to operate as a cantilever, with the gangway in cantilevered position and extended to its maximum operational length, a test load equal to $1.25 \times LL$ (live load), but not less than 300 kg, is to be applied on the gangway tip.
- (iii) If a type II gangway is designed for a LL (live load) higher than 3 persons, the test load distribution along the gangway is to be agreed on a case-by-case basis.
- (iv) The total deflections are not to exceed the values in Table 7-1 below. The test is not to cause permanent deformation.

**Table 7-1
Condition**

		Limit for δ_{\max}	Limit for δ_2
gangway supported at both ends	$SW < 2 \times TL$	$L/200$	$L/300$
	$SW = 2 \times TL$		$L/400$
	$SW > 2 \times TL$		$L/600$
cantilever gangway	$SW < 2 \times TL$	$L/100$	$L/150$
	$SW = 2 \times TL$		$L/200$
	$SW > 2 \times TL$		$L/300$



SW : gangway self-weight
TL : test load
L : gangway maximum operational length
 δ_{\max} : gangway total deflection
 δ_0 : gangway pre-camber
 δ_1 : gangway initial sag due to SW
 δ_2 : deflection due to TL

7.2.3 The gangway in uplift position

- (a) Gangways designed not to carry people in uplift position
 - (i) Load test when the gangway is in cantilevered position (simulating lift – off or loss of support at one end) and maximum operational length.
 - (ii) The following test load is to be applied at the tip of the gangway:

$$\text{Test load} = \frac{SW \times 0.25 \times L_g}{L}$$

where

SW = Self-weight of gangway

L_g = Distance from center of gangway support to gangway center of Gravity (m)

L = Maximum operational length (m)

Note:

Alternative test load and load application point may be accepted as long as the same overturning moment at the slewing bearing is achieved.

(b) Gangways designed to carry people in uplift position

(i) Type I

The following test load is to be applied at the tip of the gangway:

$$\text{Test load} = \frac{SW \times 0.25 \times L_g + F \times L_g}{L}$$

where

F = 500 kg/m² × L × w

L = Maximum operational length (m)

w = Clear width of gangway (m)

(ii) Type II

The following test load is to be applied at the tip of the gangway:

$$\text{Test load} = \frac{SW \times 0.25 \times L_g}{L} + F$$

where

F = 1.25 × maximum (LL; 120 kg)

LL = Live Load (kg)

Note:

Alternative test load and load application point may be accepted as long as the same overturning moment at the slewing bearing is achieved.

7.2.4 Slewing system

(a) Slewing system is to be tested for the horizontal design load including design wind load.

(b) The test procedure is to be agreed with the Society.

7.2.5 Breakaway system

(a) The automatic release function of the breakaway system is to be tested at full design load (vertical, horizontal including wind and combined).

- (b) The test procedure is to be agreed with the Society.

7.2.6 Telescopic test

- (a) Gangways subject to longitudinal bumper loads, a function test proving the pushing capability of the telescopic system is to be performed at 100% of the design push force.
- (b) The overload protection of the system is also to be tested.
- (c) The test procedure is to be agreed with the Society.

7.3 Examination After Testing

7.3.1 After testing, the gangway is to be examined thoroughly to observe whether any part has been damaged or permanently deformed by the test. Dismantling and/or non-destructive testing may be required if deemed necessary by the Surveyor.

7.3.2 Any overload protection system that may have been disconnected during load testing is to be reconnected. Accordingly safety valves and/or electrical circuit-breakers are to be adjusted. Set points are to be verified and sealed by the Surveyor.

7.4 Marking

7.4.1 As a minimum the gangway is to be marked on the gangway structure clearly visible with the following data:

- (a) name of manufacturer
- (b) gangway serial number or similar means of singular identification
- (c) LL - Allowable number of persons (to be marked at both ends of the gangway) – not applicable for type I gangways
- (d) clear walking width and height
- (e) operational length of gangway
- (f) operational angles of gangway.

7.4.2 To prevent effacement of the inscriptions, they are normally to be incised, punched or marked.

7.4.3 Gangways on board vessels are to be marked with a reference number to enable them to be related to their location onboard.

APPENDIX A RECOMMENDATIONS FOR PERIODICAL SURVEYS, TESTS AND REPAIRS

A.1 General

A.1.1 It is the responsibility of the owner or an appointed representative to retain current certification for each offshore gangway, to arrange for periodical survey, to record substantial repairs, modifications, etc., and to maintain adequate records to ensure traceability in accordance with class/statutory/flag requirements.

A.1.2 Before carrying out a periodic examination or test, the inspector is to refer to the initial certificate and to the periodical inspection report.

A.2 Surveys, Tests and Repairs

A.2.1 When the Society is requested to follow-up the periodical survey, the following are to be applied.

A.2.2 Gangways are to be periodically examined and tested in accordance with the schedule listed below. The Surveyor may require other or additional tests and examinations, and dismantling if considered necessary.

A.2.3 National authorities may have stricter requirements for periodical surveys which are to prevail.

Note:

If a gangway has not been in use for more than 6 months and/or has exceeded its periodic inspection date, it is to be inspected before it is taken into use again. The same applies for offshore gangways that have remained in service on an offshore installation past the due inspection date.

A.3 Annual Survey

A.3.1 To be conducted at least once every 12 months (surveys accepted to take place within 3 months before or after each anniversary date of the initial certification survey or the completion of the last Special Survey).

A.3.2 Items to be considered for Annual Survey:

- (a) structural condition (cracks, distortions, corrosion). NDT is to be applied when deemed necessary
- (b) support structure
- (c) excessive clearance in sheave-bearings and eye-bolt connections
- (d) wire-rope, including end attachments, with respect to wear, broken wires and corrosion
- (e) operational condition of slewing system (slewing bearing condition, proper lubrication, bolt condition and pretension, etc.)
- (f) operational condition of the telescoping system (including sliding surfaces)

- (g) functional operation
- (h) safety systems and alarms
- (i) leakages in hydraulic system and correct safety valve adjustment
- (j) proper arrangement and condition of electrical systems
- (k) marking (as per test certificates)
- (l) provisions for securing of the gangway during open sea conditions
- (m) fire extinguishing system (sprinkler), if relevant.

A.4 Special Survey

A.4.1 Special Surveys are to be conducted at 5 years intervals and completed within 3 months before the due date of the Special Survey.

A.4.2 Items to be considered for the Special Survey:

In addition to the examinations listed for Annual Survey the following additional surveys and load test is normally to be carried out (the attending Surveyor may apply other scope if found acceptable).

- (a) Load testing as required for Initial Certification, see 7.2
- (b) Hydraulic cylinder fixing shafts, fixed sheaves, blocks, axle pins and housing to be confirmed documented as dismantled (opened up), examined and found in order once during the last 2 years, or to be opened now.
- (c) Slewing bearings to be opened up and internal fillets, raceway and bolts to be subjected to MPI. Exemption to opening-up of a bearing will be granted provided:
 - (i) the gangway has an approved securing device (retainer) fitted or
 - (ii) the slewing bearing has been specially adapted and approved by the Society for non-destructive crack detection, or
 - (iii) a company is available, possessing method, skill and specially trained operators within nondestructive crack detection of bearings in question. The company, operators and qualification tests to be approved by the Society in each case, or
 - (iv) a procedure including regular clearance measurements established when the gangway was new, grease sampling and fatigue evaluations are adopted in agreement with the gangway and slewing bearing manufacturer.
- (d) Holding-down bolts:
 - (i) 20% of bolts are to be removed and examined. The initial 20% is to be taken in the most loaded sector of the gangway. If any significant defects are found during this examination another 20% are drawn. If any of this second set is found to be defective then all bolts are to be drawn.
 - (ii) If the first 20% are found to be acceptable and the examination is stopped, a maintenance schedule is to be established for examining the remaining 80% during the 5 years period.

APPENDIX A RECOMMENDATIONS FOR
PERIODICAL SURVEYS, TESTS AND REPAIRS

A.5 Repairs and Modifications of Gangways

- (iii) When refitting, all bolts are to be pre-stressed as stated in the gangway manual or as found on approved drawings.

A.5 Repairs and Modifications of Gangways
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A.5.1 After renewal or substantial repair of damaged parts of the primary structure of a gangway, it is to be surveyed. This may include strength testing. Renewal or repair of damaged parts are to be carried out using approved manufacturing procedures and materials which are at least equivalent to the original.

A.5.2 The repair is to be noted on the certificate and the repair report is to be attached to the certificate as an Appendix.

A.5.3 If a gangway is rebuilt, repaired with different materials or profiles with different cross sections or otherwise significantly modified (e.g. increased length, etc.), it is to be re-approved, new prototype tests according to Chapter 7 of the Guidelines may be required and a new certificate is to be issued. The old certificate is to be marked "Deleted" and attached to the new certificate.