DNV·GL

STANDARD

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Certification of offshore gangways for personnel transfer

DNV GL AS

FOREWORD

DNV GL standards contain requirements, principles and acceptance criteria for objects, personnel, organisations and/or operations.

Any comments may be sent by e-mail to *rules@dnvgl.com*

CHANGES – CURRENT

General

This is a new document.

Contents

SECTION 1 INTRODUCTION

1.1 Foreword

This standard provides technical and safety guidance for the design and certification of offshore gangways with the purpose of aiding in the development of an alternative solution for manning an offshore facility.

However, the provisions in this standard should represent the technical conclusion resulted following the selection of the appropriate gangway system.

DNV GL has developed a "Walk to Work (W2W) Guidance" - "Gangway Access to Offshore Facilities" available on DNV GL website and free to download www.dnvgl.com/w2w, to assist offshore facility operators achieve safe and efficient personnel transfers to/from their facilities via a gangway system on a workboat, ship or semi-submersible unit.

Prior to the proposal of a gangway design, it is recommended that the above mentioned document is used as a reference in better understanding the role of the gangway as an individual piece of equipment in the bigger picture of manning an offshore facility.

1.2 General

This offshore standard for certification provides criteria and guidance for certification and verification of the design, materials, fabrication, installation, testing and commissioning of gangways used offshore.

The standard provides requirements leading to the issuance of a product certificate for an offshore gangway prior to its installation on board the supporting vessel/unit.

1.3 Application

1.3.1

This standard is applicable to all gangways temporary/permanently installed on a supporting vessel, ship or mobile offshore unit (MOU), and intended to be used offshore. This standard is not valid for ship/MOU–shore gangways.

The standard does not apply to fixed gangways (bridges) permanently installed between two fixed installations.

The standard is written for worldwide application. National and governmental regulations may include requirements in excess of the provisions given by this standard.

1.3.2

This standard for certification applies to routine gangway operations connecting two stationary assets which can be:

— floating

— fixed.

Guidance note:

'Stationary' refers to units which are either maintained at position by means of dynamic positioning (DP), mooring, etc., or are fixed.

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1.3.3 Cargo transfer

The provisions in this standard may be applied when cargo transfers are performed only by means of cargo trolleys over the gangway bridge. The specifics of such a system shall be evaluated on a case-by-case basis.

Cargo transfers performed by motorized vehicles (e.g. fork lift trucks, etc.) and service/fluid transfers performed through cables and pipes/hoses are not covered in this standard (see [1.4.3]).

1.4 Scope

1.4.1 General

This standard for certification describes the procedures and requirements for obtaining certificates for offshore gangways.

The following topics are covered:

— design approval
— materials
— welding
— production
— testing.

Requirements for operational procedures and training as required for type 3 gangways (see [1.4.3]), are not part of the scope.

1.4.2 Passive and active systems

The scope of this standard covers both passively and actively motion compensated gangways.

— The design of passive motion compensated gangways incorporates features that allow the gangway to accommodate the relative motions between vessels without making use of any external systems or equipment.
— Active motion compensation implies 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.

1.4.3 Types of gangways

The standard covers the following types as related to the operation of the gangway:

Type 1 – Uncontrolled flow of people, routine personnel transfer

— people move freely between the connected units
— connection time: indefinite
— gangway is supported in X, Y and Z axis directions at both ends
— gangway shall not be permanently connected to at least one of the units
— gangway shall contain means to self-detach at one end and move away in a safe manner and short time.

Type 2 – Controlled flow of people, routine personnel transfer.

— 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 control.
— Connection time: usually less than 24 hours; the control of the flow of people shall be ensured throughout the entire connection time.
— At least one end of the gangway is supported in the X, Y and Z axis directions
— Gangway shall contain means to self-detach at one end and move away in a safe manner and short time.

Guidance note:
Connection time may be longer if it is documented that the controlled flow of people is ensured for the entire duration in which the two units are connected.

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Type 3 – Controlled flow of people, engineered personnel transfer.

— Gangways of more simplistic design to be used only in “Marine Operation” type personnel transfers.

Guidance note:
For definitions of "routine personnel transfer" and "engineered personnel transfer" see [1.7.2].

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1.5 Structure

This document is structured as follows:

— Sec.2 provides information regarding documentation and certification requirements.
— Sec.3 to Sec.6 define the technical requirements applicable to type 1 and type 2 offshore gangways. Topics covered within these sections include, materials and fabrication, structural design and strength, functional and safety requirements.
— Sec.7 addresses the testing and marking requirements.
— Sec.8 defines the specific technical requirements for type 3 gangways
— App.A covers the recommendations for periodic examinations, tests and repairs

1.6 References

Only the latest revision of the following referenced standards shall be used:

Table 1-1 References

Reference	*Title*
	DNV Rules for Classification of High Speed, Light Craft and Naval Surface Craft
	DNV Rules for Classification of Ships
DNV Classification Note No. 30.7	Fatigue Assessment of Ship Structures
DNV-RP-C205	Environmental conditions and environmental loads
DNV Standard for Certification 2.7-3	Portable Offshore Units
DNV Standard for Certification No. 2.22	Lifting Appliances
DNV Standard for Certification 2.9	Hydraulic Cylinders
DNVGL-OS-A101	Safety principles and arrangements
DNVGL-OS-A201	Winterization for cold climate operations
DNVGL-OS-B101	Metallic materials
DNVGL-OS-C101	Design of offshore steel structures, general LRFD method
DNVGL-OS-C401	Fabrication and testing of offshore structures
DNVGL-OS-H101	Marine operations general
DNVGL-OS-H205	Lifting operations
DNVGL-RP-H101	Risk management in marine - and subsea operations
DNVGL-RP-0005	Fatigue design of offshore steel structures
DNVGL-RU-OU	DNVGL rules for classification: Offshore units (OU)
DNVGL-RU-SHIP	DNVGL rules for classification: Ships (SHIP)
EN 13001-3-1	Cranes General Design
EN 1993-1	Design of steel structures (Eurocode 3)
EN 1999-1	Design of Aluminium Structures (Eurocode 9)
EN 1993-6	Crane Supporting Structures
IEC 61508	Functional Safety
	MODU Code

1.7 Definitions

1.7.1 Abbreviations

Table 1-2 Abbreviations

Abbreviation	*Description*
CoG	center of gravity
DF	dynamic factor
DFF	design fatigue factor
HAZID	hazard identification analysis
HAZOP	hazard and operability study
HPU	hydraulic power unit
IACS	International Association of Classification Societies
LL	live loads; for marking purposes, it shall represent allowable number of persons on the gangway at one moment
LRFD	load and resistance factor design
MOA	maximum operational accelerations
MOU	mobile offshore units
MPS	manual protection system
MTA	maximum transit/parked accelerations
NDT	non destructive testing
TD	design temperature
VIV	vortex induced vibrations
WSD	work stress design

1.7.2 Definitions

Table 1-3 Definitions

Term	*Definition*
DNV GL inspection certificate 3.2	a document signed by a surveyor of DNV GL and accepted by the manufacturer's authorized inspection representative, covering the results of the required tests It shall certify that the tests have been carried out by the manufacturer in the presence of the surveyor according to the Rules or according to special agreement on samples taken from the delivered products direct.
DNVGL certificate (VL)	A product or material certificate validated and signed by a surveyor from DNV GL will be denoted a VL certificate. (ref. DNVGL-RU-SHIP-Pt.1 Ch.3 Sec. 5)
routine personnel transfer	'everyday' routine personnel transfer, without specific supporting documentation (i.e. DNV GL approved personnel transfer procedure)
manned personnel transfer	engineered/marine personnel transferring operation (over a gangway) of short duration (usually less than 4 hours) covered by specific operational procedures
engineered personnel transferring operation (over a gangway)	short term operation (less than 4 hours – time frame in which the environmental parameters can be considered stationary) under continuous monitoring of a landing and transfer coordinator
landing and transfer coordinator	person in charge of the engineered personnel transferring operation; ensures that all aspects of the personnel transferring operation are according to the DNV GL approved personnel transfer procedure; shall possess a thorough knowledge and have experience with the actual operation
personnel transfer procedure	document describing in detail all phases of the personnel transferring operation

Table 1-3 Definitions (Continued)

Term	*Definition*
product certificate (PC)	A compliance document validated and signed by the issuing organization: — identifying the product that the certificate applies to — confirming compliance with referred requirements. It is required that: — The tests and inspections have been performed on the certified product itself, or on samples taken fromthe certified product itself. — The tests were witnessed by a qualified representative of the organization issuing the certificate, or his authorized representative (ref. DNVGL-RU-SHIP-Pt.1 Ch.3 Sec. 5).
weight of one fully kitted person (including luggage/tools)	100 kg; to be used for establishing the live load (LL) of the gangway (for type 2 and 3 gangways)
clear width	width of gangway from toe-board to toe-board or hand rail to hand rail, whichever is the smallest If the width varies along the length of the gangway, the smallest width shall represent the 'Clear width'.
gangway axis	— X axis: principal axis oriented along the length of the gangway — Y axis: secondary axis, perpendicular to X axis, oriented across the length of the gangway and in the floor/walkway plane — Z axis: secondary axis, perpendicular to the plane defined by X and Y axis.

1.7.3 Verbal forms

Table 1-4 Verbal forms

Term	*Definition*
shall	verbal form used to indicate requirements strictly to be followed in order to conform to the document
should	verbal form used to indicate that among several possibilities one is recommended as particularly suitable, without mentioning or excluding others, or that a certain course of action is preferred but not necessarily required
may	verbal form used to indicate a course of action permissible within the limits of the document

SECTION 2 DOCUMENTATION AND CERTIFICATION

2.1 Documentation

2.1.1 Documentation

2.1.1.1 Overview

The documentation and information requirements stated below are required for design approval and ensuing certification.

Table 2-1 Documentation requirements

Object	*Document type*	*Additional description*	*Gangway Info*
General	C010 - Design criteria	Operational limitations (principal loads, environmental loads, vessel motions, etc) Gangway type, see [1.4.3]	For Information (FI)
	C020 - Assembly or arrangement drawing	A drawing showing how the parts of a mechanical assembly are arranged together.	FI
	C030 - 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 shall contain relevant parameters including torque capacity	Approved (AP)
	C040 - Design analysis	See [2.1.1.2]	FI
	C050 - Non-destructive testing (NDT) plan	A document describing the methods, extent and criteria for the non-destructive testing that shall be performed.	AP
	Z060 - Functional description	A document describing: — all functions incorporated in the system and their technical realization — all interfaces towards other systems, including their technical realization.	FI
	Z252 - Test procedure at manufacturer	A document describing the test configuration and test methods for testing at the manufacturer's works, specifying for each test: — initial condition — how to perform the test — what to observe during the test and acceptance criteria for each test. The tests shall cover normal modes and failure modes.	AP
	Z253 - Test procedure for quay and sea trial	As above	AP
	Z161 - Operation manual	See [2.1.2]	FI
Power supply	Z030 - Arrangement plan	A drawing showing the arrangement of a specified system. All major equipment shown on the drawing shall be identified by tag number and name. Type and maker of prime mover or specification of other main and emergency power supply, including mechanical components.	FI
Electric power system	E170 - Electrical schematic drawing	A schematic drawing showing the configuration of the electrical circuits. Information on protection, synchronization, interlocks, under voltage trips, remote control circuits, cable list, etc. shall be included if relevant.	AP
	Z090 - Equipment list		FI

Table 2-1 Documentation requirements (Continued)

Object	*Document type*	*Additional description*	*Gangway Info*
Hydraulic power system	S011 – Piping and instrumentation diagram (P&ID)	A diagrammatic drawing including the following: — 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 — 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.	AP
	S042 - 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, shall be stated. The failure mode of the components, e.g. close on loss of power, shall be stated.	AP
	Z060 - Functional description	As above	FI
	Z090 - Equipment list		FI
Control and monitoring	I200 - Control and monitoring system documentation	A documentation package providing information corresponding to the following set of documentation types, as relevant: — I020 Control system functional description — I030 System block diagram (topology) — I040 User interface documentation — I050 Power supply arrangement — I080 Data sheets with environmental specifications — I110 List of controlled and monitored points — I150 Circuit diagrams — I320 Software change handling procedure — Z252 Test procedure at manufacturer. Functional description of safety system and the safety equipment to be included	AP

Table 2-1 Documentation requirements (Continued)

Object	*Document type*	*Additional description*	*Gangway Info*
Fire safety	G060 - Structural fire protection drawing	A drawing showing the arrangement of the structural fire protection, including: — 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.	AP

2.1.1.2 Design analysis

For structural parts and components above, the drawings shall be supplemented with calculations demonstrating that the structural strength complies with the requirements.

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

A complete listing of structural components and parts subjected to strength calculations shall be submitted. The list shall include information of:

— types of failures considered (excessive yielding, buckling, fatigue fracture)
— elastic or plastic analysis performed
— permissible stress (WSD) or limit state method (LRFD) used.

See also Sec.4.

2.1.2 Operation manual

A manual shall 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:

— 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.
— Normal use of the gangway with information of:
  — deployment/retrieval procedures
  — operational procedure (preparations prior to personnel transfers, control of flow of people, etc.).
— Emergency procedures with information of:
  — fixed procedures as to when the gangway connection shall be interrupted and when it can be re-established (hazard identification).
— Differentiation/definition of controlled vs auto-lift situations.
— Continuous maintenance and repair routines to ensure that the gangway and all the appurtenant systems function properly at all times.

Guidance note:
Further guidance on the information to be included in the gangway manual may be found in EN 13852-1 Section 7.

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2.2 Certification

2.2.1 General

Slew-bearings and load holding cylinders. Product certificates are in general issued based on material certification, design approval, prototype or production testing.

Pedestal flange shall be approved according to DNV 2.22.

Pedestals and pedestal adapters shall be designed based on the requirements for the same gangway type as that of the gangway.

Table 2-2 and Table 2-3 list the certificate requirements for offshore gangways:

Table 2-2 Certificate requirements for offshore gangways

Object	*Certificate type*		Additional description
Slewing rings	VL	DNV GL product certificate	
Hydraulic cylinders	VL	DNV GL product certificate	Applicable also for accumulators
Winches	VL	DNV GL product certificate	for wire luffing gangways
Sheaves	VL	DNV GL product certificate	Product certificate (PC) issued by manufacturer certificate will be satisfactory for un-welded sheaves
Wire ropes	CG4	Certificate of test and thorough examination of Wire Rope	Alternatively ILO form No. 4
Transmission gears and brakes	PC	Product certificate issued by manufacturer	Applicable when transmitting braking forces for luffing and telescoping
Slewing gear	PC	Product certificate issued by manufacturer	Also other transmission gears for non-critical applications
Hydraulic components	TR-T	Test report, test	except mountings

Table 2-3 Additional requirements for motion compensating systems

Object	*Certificate type*		*Additional description*
Control and monitoring system	VL	DNV GL product certificate	
EL-motors with rating 100 kW and above	VL	DNV GL product certificates	
Motor starters and frequency converters with rating 100 kW and above	VL	DNV GL product certificates, or, type approval (TA) certificates	
Slip rings, 100 kW and above	VL	DNV GL product certificate	

2.2.2 Certification procedure

2.2.2.1 General

The following activities are covered by this standard:

— design examination
— survey during fabrication and installation
— witness testing and marking.

2.2.2.2 Design examination

Load-carrying and other important components of a gangway are subject to design examination with respect to strength and suitability for its purpose. A design approval is granted when the design examination has been concluded without detection of non-compliances towards this standard.

Strength examination of components related to power supply and safety equipment is not part of the scope of this document.

Each gangway is normally given a separate design approval.

The design approval may be obtained either on a case-by-case basis or as a general approval, type approval.

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 DNV Standard for Certification No. 1.2 *Type Approval* (latest issue).

2.2.2.3 Survey during fabrication and installation

Normally, a survey during manufacture of each separate gangway shall be carried out by DNV GL's surveyor in order to ascertain compliance with the approved drawings, other requirements of this certification standard 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 DNV GL.

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.

2.2.2.4 Testing and marking

Testing and marking shall be performed as per Sec.7 requirements.

2.2.2.5 Extension of Scope of work

Upon request from the customer, the scope of work may be extended beyond the subjects and aspects covered in this certification standard. Extensions shall be agreed in writing. DNV GL 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 shall 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 DNV GL interpretation will prevail.

2.2.2.6 Reduced 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 certification standard. This will be annotated in the documentary evidence of the completed assignment (certificate).

DNV GL 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

As a minimum the certificate shall contain:

- reference to a signed "factory acceptance tests" report
- design parameters/limitations given in approval letter or type approval certificate
- list of certified sub-components
- list of tests to be carried out after installation onboard (reference to the approved "testing procedure for quay and sea trial").

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

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DNV GL's formal documentation of the certification to the customer will be the product certificate issued upon completion of the project.

2.3 In operation follow-up

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.

Such periodic inspection may be required to be carried out by DNV GL 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.

A recommended scope for an annual inspection is given in App.A.

Notwithstanding the above, major repairs or modifications which may alter the certificate shall be approved by DNV GL.

SECTION 3 MATERIALS AND FABRICATION

3.1 General

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

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

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

As an alternative, materials that comply with national or proprietary specifications may be accepted provided such specifications show reasonable equivalence to the requirements in DNVGL-OS-B101 or are especially approved.

3.2 Design temperature

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

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

For gangways installed on vessels or mobile offshore units classified by DNV GL, the design temperatures of the gangway and the supporting vessel/unit are recommended to be compatible.

If not otherwise specified, the design temperature shall be -20°C (corresponding extreme low air temperature: -35°C, see DNVGL-OS-A201 Ch.1 Sec.1).

3.3 Structural category

The following categorization will be used for structural members:

— Special: Highly stressed areas where no redundancy for total collapse exists.
— Primary: Structures carrying main load as well as components with highly stressed areas.
— Secondary: Structures other than primary and special members.

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

The categories shall be agreed with DNV GL in each case.

Bolt connections shall be categorized according to DNV Standard for Certification 2.22 Ch.2 Sec.1 4.4.1.

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

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3.4 Material manufacture survey, certification and testing procedures

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

For testing/retesting procedures and requirements, see DNVGL-OS-B101, as applicable.

DNV GL approved material manufacturer will not be required.

For slewing rings, DNVGL inspection certificate 3.2 is required unless otherwise agreed.

The materials shall be adequately marked for identification. The marking shall at least comprise name or trade mark of the manufacturer, material grade, heat number, and for 3.2 certificates, either the stamp of the purchaser's authorized inspection representative or the inspector of a flag/state recognized body.

Marking and identification of smaller items, e.g. bolts and nuts, shall be especially agreed upon between manufacturer and DNV GL, but shall at least comply with fastener product standard.

Materials without proper identification shall 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

3.5.1.1 General

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

The requirements to chemical composition, mechanical properties, etc. are given in DNVGL-OS-B101.

As an alternative, materials that comply with national or proprietary specifications may be accepted provided such specifications show reasonable equivalence to the requirements in DNVGL-OS-B101 or are especially approved.

The grade of steel to be used shall in general be related to the service temperature and thickness for the applicable structural category, ref. DNVGL-OS-C101 Table 3-5.

3.5.1.2 Impact test

Required impact test temperatures are dependent on design temperature TD and the material thickness. Impact test temperatures are given in Table 3-1 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 shall 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 shall apply, provided that the thicker plate does not contain butt welds:

The impact test temperature shall be the lower of the temperatures according to Table 3-1, based on t_1 or 0.25 x 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) shall not 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]
$6 \le t \le 12$ [3]	$T_D + 10$	Test not required

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]
12 < t ≤ 25	T_D	Test not required
25 < t ≤ 50	T_D - 20	T_D
t > 50	T_D - 40	T_D - 10

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 shall not be taken higher than 0°C and not lower than -60°C.
2) See [3.3] for definitions.
3) For plate thickness less than 6 mm, Charpy V testing will not be required.

Acceptance criteria shall be as per DNVGL-OS-B101.

3.5.2 Rolled structural steel not for welding

3.5.2.1 General

Rolled steel for special and primary components other than those mentioned in [3.5.2.2] and [3.5.2.3] (e.g. mechanisms) shall be specified with reference to a recognized standard. The material shall be delivered in the following conditions:

— carbon and carbon/manganese steel in normalized condition
— alloy steel in quenched and tempered condition
— as rolled (AR) condition, when subjected to special consideration.

For all materials, impact toughness shall be documented by Charpy V-notch impact tests. Test temperatures shall be as specified in Table 3-1 but, in the case of low calculated stresses, e.g. not exceeding 50 N/mm^2, a test temperature of 20°C will be accepted. Required minimum impact energy shall be as required for welded parts, ref. [3.5.1.2].

3.5.2.2 Bolts and nuts

Materials for bolts and nuts shall comply with the requirements in [3.5.4] for bolts and nuts. This includes requirements for chemical composition and mechanical properties.

3.5.2.3 Rolled rings

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

3.5.3 Steel forgings

3.5.3.1 Steel forgings

Steel forgings shall comply with the requirements in DNVGL-OS-B101.

As an alternative, materials that comply with national or proprietary specifications may be accepted provided such specifications show reasonable equivalence to the requirements in DNVGL-OS-B101 or are especially approved. As a minimum the following particulars shall be specified: manufacturing process, chemical composition, heat treatment, mechanical properties and non-destructive testing. For machinery components, see DNV GL rules for classification: Ship rules Pt.4 Ch.2 Sec.3.

Impact testing requirements shall not be less than those in Table 3-2

Table 3-2 Impact testing for steel forgings

Design temperature T_D	*Test temperature*	*Minimum Charpy value*
$T_D \geq$ -20°C	0°C	27 J
-20°C > T_D > -30°C	-20°C or (0°C)	27 J (48 J)

3.5.3.2 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 DNV GL. All relevant details shall 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 shall be indicated. Method and extent of non-destructive testing shall be specified and the testing procedures shall be stated. Detailed information about method of manufacture shall 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 shall be carried out. This means that DNV GL may impose additional requirements not specified in this standard. The results shall be submitted to DNV GL for consideration. The programme for such examination shall be agreed with DNV GL.

All test results shall comply with the approved specifications.

Steel for slewing rings shall satisfy the requirements of Table 3-3.

Table 3-3 Slewing materials

Heat treatment		*According to approved specification*
Charpy V-notch test temperature		T_D
	Average	42
Charpy V-notch value	Single min. value	27
Elongation A5		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

Bolt connections are normally considered to be in the following groups:

Special – where it is part of a slewing ring connection.

Primary – where the bolts or nuts are transferring principle loads

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.

Bolts and nuts for use in connections categorized as special or primary shall conform with and be tested in accordance with a recognized standard, e.g. pertinent parts of ISO 898 or other recognized standard.

Additional requirements to testing and inspection of slewing ring bolts are given in Table 3-4.

Table 3-4 Testing and inspection of slewing ring bolts

Strength Class, ISO 898, or equivalent	*Diameter d in mm*	*Ultimate strength N/mm²*	*Yield strength. Minimum N/mm²*	*Elongation A5*	*Required Charpy V energy 1) at test temp. as required for rings Table 3-3*	*Fracture mechanics testing (CTOD)*	*Surface inspection 2)*
8.8	d < 25	800 - 1000	640	14	—	—	Visual
	d ≥ 25				42 J	—	Visual and magnetic particle (MPI)
10.9 3)	d < 25	1000 - 1200	900	12	—	—	Visual
	d ≥ 25				42 J	—	Visual and magnetic particle (MPI)

1) Average value. Single value accepted to be 30% lower.

2) For all the bolts (100%), magnetic particle testing shall be carried out at least 48 hours after completion of quenching and tempering for bolts with yield strength above 355 N/mm². Inspection shall be in accordance with ASTM E 709.
Depth of longitudinal discontinuities shall not 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.

Bolt connections considered as secondary shall be made from suitable materials.

Nuts may be accepted to be in one strength class lower than the bolts of bolt/nut assemblies.

Bolts and nuts shall be delivered with the following certificates as per EN10204, verifying compliance with the material requirements and other test requirements:

— DNV GL Inspection certificate type 3.2 for slewing ring bolts and nuts.
— 2.1 test report for bolts and nuts in primary and secondary connections.

Slewing ring bolts shall have rolled threads, and the rolling shall be performed after final quenching and tempering of the bolts. 12.9 bolts are not accepted as slewing ring bolts.

Fasteners (bolts, nuts and washers) in marine environment shall normally 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 shall be followed by immediate hydrogen-relief (degassing) treatment to eliminate the risk of hydrogen embrittlement.

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 shall comply with the requirements in DNVGL-OS-B101.

3.5.6 Steel pipes, tubes and fittings

Steel pipes, tubes and fittings shall comply with the requirements in DNVGL-OS-B101.

3.5.7 Aluminium alloys

Aluminium alloys shall comply with the requirements in DNVGL-OS-B101.

3.5.8 Steel wire ropes

Steel wire ropes shall comply with the requirements in DNV Standard for Certification 2.22 Ch.2 Sec. 1 9.

3.6 Fabrication and testing

3.6.1 General

The manufacturer shall have a system for quality control involving competent personnel with defined responsibilities that shall cover all aspects of quality control. For qualification of welders, reference is made to DNVGL-OS-C401. The materials shall be identifiable during all stages of manufacturing and construction.

Manufacturing and construction shall be in accordance with the approved drawings and specifications. The specification shall refer to recognized codes, standards or rules relevant for the structure in question. Supplementary requirements amending the reference documents may be stipulated.

Dimensional tolerances specified in the design analysis of the gangway structures shall be complied with during manufacturing and construction.

All defects and deficiencies shall be corrected before the structural parts and equipment are painted, coated or made inaccessible.

Alternative methods of making joints may be considered by DNV GL and will be subject to consideration in each case.

3.6.2 Forming of materials

Forming of materials shall comply with the requirements in DNVGL-OS-C401.

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) shall comply with the requirements in DNVGL-OS-C401.

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

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

For forged components:

— IACS Recommendation no.68, Inspection zone 1

For cast components:

— IACS Recommendation no.69, Quality level 1

NDT testing shall be focused on critical areas. Extent to be specified by the manufacturer and shall be according to recognized standards.

Guidance 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 DNV GL are obtained.

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3.6.5 Material protection against corrosion

3.6.5.1 Steel

Steel surfaces exposed to marine atmospheric conditions shall 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 shall be protected by other protective systems such as oil, grease, grouting etc.

Bolts, nuts and associated elements shall 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 DNV GL.

3.6.5.2 Aluminium

Corrosion protection for aluminium alloys shall comply with the requirements in DNV Rules for High speed, Light Craft and Naval Surface Craft Pt.3 Ch.3 Sec.2.

Other protection methods may be accepted upon special consideration by DNV GL.

3.6.5.3 Steel and aluminium connections

In areas exposed to green sea/ sea spray, a non-hygroscopic material shall be applied between steel and aluminium in order to prevent galvanic corrosion. Bolts with nuts and washers shall be of stainless steel, quality A4-316 or equivalent.

Horizontal inertia forces in bolted connections may be required to be taken up by metal to metal stoppers with insulation tape in the gap.

Aluminium superstructures that are provided with insulating material between aluminium and steel shall be earthed to the hull. See DNVGL-RU-SHIP-Pt4Ch8 Sec.2.

SECTION 4 STRUCTURAL DESIGN AND STRENGTH

4.1 Design loads

4.1.1 General

The loads to be considered in the analysis of structures are divided into:

a) principal loads (see [4.1.2])
b) vertical loads due to operational motions (see [4.1.3])
c) horizontal loads due to operational motions (see [4.1.4])
d) loads due to climatic effects (see [4.1.5])
e) loads due to motion of the vessel on which the gangway is mounted (see [4.1.6]).

The determination of the loads specified by the designer shall be documented with enclosed calculations, references to standards, or other justification.

In addition to the below stated loads, other relevant loads shall be considered, as applicable.

4.1.2 Principal loads

— the loads due to dead weight of the components: self-weight of the structure and all installed equipment;
— the loads due to live load.

In addition, the following loads shall be considered, as applicable:

— Loads due to self-weight of:
  — personnel waiting area (see [5.6])
  — access to the gangway and/or waiting area (see [5.6])
  — driver's cabin.
— 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).

4.1.3.1 Inertia forces due to acceleration or deceleration of vertical motions

Forces shall 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 shall be taken into account by multiplying the self-weight of the gangway by a "dynamic factor - DF_Z" (see Table 4-4 and Table 4-5 note 2).

The dynamic factor shall be calculated by the designer based on the stiffness of the gangway taking into account all elements from gangway tip to pedestal; however, it shall not be less than 1.10.

For the dynamic case (LC 2b), these shall 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 should be noted that these horizontal forces act in addition to possible simultaneously acting horizontal components of the principal loads, see [4.1.2].

4.1.4.1 Inertia forces due to acceleration or deceleration of horizontal motions

Forces shall 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 shall be taken into account when this effect is significant.

The lateral force to be applied at the gangway (bridge) center of gravity (CoG) shall be calculated based on the below formula:

$F_H\,(kg)$ = (SW/100) x (2.5 + 0.1 x r x n) ≥ 5% x SW 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

Alternatively, the inertia forces shall be taken into account by multiplying the self-weight of the gangway by a "dynamic factor – DF_Y" (see Table 4-4 and Table 4-5 note 2); DF_Y shall not be less than 1.05.

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

4.1.4.2 Centrifugal forces

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

CF (kg) = (SW/1000) x (n^2 x r)

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

4.1.5 Loads due to climatic effects

4.1.5.1 Ice and snow load

Ice accretion from sea spray, snow, rain and air humidity shall be considered, where relevant. Snow and ice loads may be reduced or neglected if snow and ice removal procedures are established.

When determining wind load, possible increases of cross-sectional area and changes in surface roughness caused by icing shall be considered, where relevant.

For gangways designed to be used on vessels with the **WINTERIZATION** class notation, the requirements in DNVGL-OS-A201 Ch.2 Sec.4 shall be considered as a minimum.

Guidance note:
The same requirements may be applied upon request from the customer.

Compliance/non-compliance with the above requirements may be mentioned in the certificate.

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4.1.5.2 Wind load

Generally, the wind loads on the gangway shall be calculated according to the simplified method in DNV Standard for Certification 2.22 appendix A.

Guidance note:
For a more complex approach, DNV RP-C205 or other internationally recognized standards may be used.

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The below wind speed values are in accordance with the provisions in DNV Standard for Certification 2.22 Appendix A table A-2 at 10 m above sea level. The wind speed/pressure shall be modified accordingly for the gangway location with the variation of height.

The design wind velocity and pressure shall be based on one-minute mean gust wind speed at the gangway location.

— For the operational case, the design wind speed should not be less than 20 m/s. The gangway should be parked when the one-minute mean gust wind speed exceeds this value.

— For the deployment/retrieval case, the design wind speed shall not be less than the "Operational design wind speed" – recommended value: 36 m/s.
— For the transit/survival/parked case, the design wind speed shall not be less than 44 m/s.

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) shall be in accordance with MODU Code Chapter 3 requirements (i.e. 51.5 m/s transit/survival/parked wind speed).

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 shall 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).

4.1.5.3 Vortex induced oscillations

Consideration of loads from vortex shedding on individual elements due to wind, current and waves may be based on DNV-RP-C205. Vortex induced vibrations of frames shall also be considered. The material and structural damping of individual elements in welded steel structures shall not 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 should 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 should therefore be designed according to an avoidance criterion that will ascertain that the structure will not vibrate.

4.1.5.4 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 shall be calculated according to DNVGL-RU-SHIP-pt3Ch4 Section 5 and DNV Classification note no. 8.

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

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.

The vessel/MOU accelerations for the parked/transit/survival case shall be based on the extreme values given in the governing code for the supporting vessel/MOU.

The vessel accelerations for the operational and deployment/retrieval cases shall be stated by the designer.

The inertia forces caused by the vessel motions shall be combined according to relevant rules/calculations for the vessel/MOU considered. Alternatively, combinations of the maximum values may be used:

— vertical force alone
— vertical and transverse force
— vertical and longitudinal force
— vertical, transverse and longitudinal force.

Typical values for the calculated accelerations may, for a ca. 180 m ship with 60 000 tonnes displacement and the gangway near the bow/aft, be:

— Combined[1)] vertical acceleration: $a_V = 1.0 \cdot g$
— Combined[1)] transverse acceleration: $a_T = 0.7 \cdot g$
— Combined[1)] longitudinal acceleration: $a_L = 0.3 \cdot g$

[1)] 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

Exceptional/accidental loads are loads related to abnormal operations or technical failure. Examples of accidental loads are loads caused by:

- dropped objects
- collision impact
- explosions
- fire
- extreme vessel accelerations
- extreme wind.

Relevant accidental loads should be determined on the basis of an assessment and relevant experiences. With respect to planning, implementation, use and updating of such assessment and generic accidental loads, reference is given to DNVGL-OS-A101.

Accidental load combinations shall be evaluated on a case-by-case basis. Stress acceptance levels shall be as per load case III.

4.2 Load Combinations

4.2.1 General

Listed below are six general load combinations to be considered. Applicability of each load combination, as well as any additional relevant load combination(s) shall be evaluated and agreed with DNV GL on a case-by-case basis.

1) Normal working condition, the gangway in operation mode (transferring people to-from another unit). (Load case I and II)
2) In uplift situation (deployment/retrieval). (Load case I and II)
3) Emergency lift off. (Load case III)
4) Parked position. (Load case II and III)
5) Test load. (Load case III)
6) Offshore lifting.

For gangways intended to be installed on the supporting vessel/unit offshore, the gangway structure shall also be evaluated for the offshore lifting case; the assessment shall be based on an internationally recognized standard (e.g. DNV 2.7-3 as a type 'C' structure, DNV-OS-H205, etc.).

Guidance note:
For load case I, II and III permissible stresses with respect to yielding and buckling, see [4.3].

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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 shall be dimensioned for the most unfavorable condition(s).

A general overview of the proposed load combinations for type 1 and 2 gangways is presented in Table 4-4 and Table 4-5.

4.2.2 Normal working condition

The following normal working conditions are defined:

- principal Loads: self-weights and live loads as per [4.1.2]
- loads due to climatic effects: as per [4.1.5]; wind speed: "operational"
- loads due to motion of the vessel on which the gangway is mounted (maximum operational accelerations), ref. [4.1.6].

Other relevant conditions shall be agreed with DNV GL on a case by case basis.

4.2.3 Deployment/retrieval (gangway in uplift situation)

The following uplift conditions are defined:

— Principal loads: self-weights and live loads as per [4.1.2].

Guidance note 1:
Live loads on gangway and waiting area assumed to be 0.

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— Vertical loads due to operational motions as per [4.1.3].
— Horizontal loads due to operational motions as per [4.1.4].

Guidance note 2:
Unless luffing and slewing are performed at the same time, the effect of the Vertical and Horizontal loads needs not to be combined.

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— Loads due to climatic effects: as per [4.1.5]; wind speed: 'Deployment/retrieval'.
— Loads due to motion of the vessel on which the gangway is mounted (maximum operational accelerations), ref. [4.1.6].

Other relevant conditions shall be agreed with DNV GL on a case by case basis.

4.2.4 Emergency lift-off

The following emergency lift-off conditions are defined:

— Principal loads: self-weights and live loads as per [4.1.2].
  — live load on gangway applied at tip
  — gangway length: maximum operational length plus safety length.
— Vertical loads due to operational motions as per [4.1.3].
— Loads due to climatic effects: as per [4.1.5]; wind speed: 'Deployment/retrieval'.
— Loads due to motion of the vessel on which the gangway is mounted (maximum operational accelerations), ref. [4.1.6].

Other relevant conditions shall be agreed with DNV GL on a case by case basis.

4.2.5 Parked position/Transit

The gangway is parked when completely pulled-in and supported at the free-end in a cradle/bridge rest:

— principal loads: self-weights as per [4.1.2]
— loads due to climatic effects: as per [4.1.5]; wind speed: "transit/survival"
— loads due to motion of the vessel on which the gangway is mounted (maximum transit/survival accelerations), ref. [4.1.6].

Additional considerations:

— 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.
— 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 should, ensure that the gangway does not interfere other equipment, not only for working condition, but also for transport condition.

— 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

It shall be shown that structures and components have the required safety against the following types of failure:

— excessive yielding (see [4.3.2])
— buckling (see [4.3.3])
— fatigue fracture (see [4.3.4]).

The safety shall 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 shall be considered.

The strength calculations shall 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.

The verification of safety may be based on the permissible stresses method (WSD) or the limit state method (LRFD). With the factors given in this standard there will be only a formal difference between the two methods. If LRDF method is used, the below factors shall 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

For steel structures, the capacity check shall normally be based on DNV GL Rules and Standards or alternatively other internationally recognized standards (e.g. EN 1993-1 or NORSOK). When EN 1993-1 is applied, the material factors shall be:

— γ_{M0} and γ_{M1} = 1.15
— γ_{M2} = 1.3
— for capacity checks where other material factors (γ_{Mi}) than those defined above are used, γ_{Mi} as defined by EN 1993-1 shall be multiplied with an additional γ_{ST} = 1.05. The calculated material factors shall, however, not be taken less than 1.15.

Guidance note:
Material factor symbols and definitions are in accordance with EN 1993-1.

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For aluminium structures, the capacity checks shall normally be based on EN 1999-1 or equivalent internationally recognized standards. When EN 1999-1 is applied, the material factors to be used shall be taken as specified in EN 1999-1 and multiplied with an additional γ_{AL} = 1.1. The calculated material factors shall, however, not be taken less than 1.2.

If capacity checks are based on other structural design standards, the material factors shall be agreed with DNV GL on a case-by-case basis.

For structures with nonlinear behavior, however, significant differences may occur. In such cases the limit state method shall be used, or the safety factor shall refer to load and not to stresses.

4.3.2 Checking with respect to excessive yielding

4.3.2.1 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 shall be used 0.8 x σ_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 shall not 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 shall be based on an internationally recognized standard.

4.3.2.2 Aluminium

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

4.3.3 Checking with respect to buckling

The guiding principle is that the safety against buckling shall 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 should 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.

The safety factors given in Table 4-2 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 means that elastic buckling stress does not exceed the yield strength.

Calculation methods and corresponding required safety factors as specified by other internationally recognized standards for structural design may also be used.

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	σ_y /1.50	σ_y /1.33	σ_y /1.10

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

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

4.3.4 Checking with respect to fatigue

Checking with respect to fatigue shall be based on an internationally recognized standards applicable for structures intended to be used offshore (e.g. DNVGL-RP-0005, DNV Classification Note No. 30.7, etc.).

The fatigue assessment shall be performed on the gangway structure considering the cumulative damage effects of both the operational (including deployment/retrieval) and transit/parked cases and shall consider (but not limit to) the following gangway specifics:

- Operation time: not less than 20 years.
- Translation and/or rotation cycles in the directions/around X, Y and Z axis (e.g. telescoping, luffing, slewing, etc.).
- Loads due to motion of the vessel on which the gangway is mounted.
- Wind load may usually be excluded.
- Type 1 only: On and off-load cycles at full Live load: not less than 6/day (e.g. 3 working shifts).

Note: The on and offload cycles shall be agreed with DNV GL and be noted in the certificate.

Guidance note:
On-load: - gangway subject to full LL

Off-load: - gangway completely unloaded (LL=0)

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- Deployment/retrieval cycles/day.
- The design fatigue factor (DFF) shall not be less than 2 (for definition of DFF see DNVGL-OS-C101).
- The load combinations for the fatigue assessment can be based on the load combinations defined in Table 4-4 and Table 4-5 (as applicable).
- Stress acceptance levels according to the fatigue standard used.

The stress range spectrum shall be defined by the designer considering the above minimum limitations. Different fatigue design parameters shall be agreed with DNV GL on a case by case basis.

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 shall also be evaluated, if relevant.

4.3.5 Design and strength of particular components

4.3.5.1 General

The design and strength of particular components, such as slewing bearings, flanges, pedestals and pedestal adapters shall be based on DNV Standard for Certification 2.22 Ch.2 Sec. 2 4 requirements.

4.3.5.2 Wheel rolling on rail/structure

Calculation of stress shall be done according to EN 13001-3-1 Annex C.4.

EN 1993-6 part 5 or other applicable internationally recognized standards shall be used if the wheel and runway beam design is not covered in EN 13001-3-1 Annex C.4. These standards shall be agreed with DNV GL.

Alternatively, FE calculations shall be provided.

4.3.5.3 Hydraulic Cylinders

Requirements regarding cylinder wall thickness are described in the DNV Standard for Certification No. 2.9.

Requirements regarding wall thickness of tubes are described in DNVGL-RU-SHIP-PT4Ch6 Sec 9 Tables 2, 3 and 4.

Welds shall normally be full penetration welds. Other than full penetration welds may be accepted on a case-to-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.

The design calculations for hydraulic cylinders shall 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 shall be evaluated.

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 shall be applied.

EN 13445 part 3, EN 14359 or other applicable internationally recognized standards shall be used for designing various hydraulic cylinder details, unless specified in DNV Standard for Certification No. 2.9. These standards shall be agreed with DNV GL.

4.3.5.4 Winches

For wire luffing gangways, the wire luffing winch shall be designed based on DNV Standard for Certification 2.22 Ch.2 Sec.3 2.1 and Ch.2 Sec. 9 5 requirements.

4.4 Design loads type 1 gangways

Type 1 gangways shall normally be evaluated based on the load combinations defined in [4.2]. Other design specific loads and load combinations shall be evaluated on a case-by-case basis.

Type 1 specific design requirements:

- Normal working condition: Live load on the gangway 400 kg/m^2.
  - where live load shall be evenly distributed across the effective load area of the gangway and:
  - width of gangway for calculating the load shall be the clear width
  - length of loaded gangway shall be the maximum operational length without the safety length.
- Emergency lift-off: Live load on the gangway tip 600 kg.

Below Table 4-4 summarizes the load combinations and acceptance criteria for type 1 gangways.

Table 4-4 Type 1 - load combinations[5)]

	LC 1a	LC 1b	LC 2a	LC 2b	LC 3	LC 4
	Normal working condition *(ref. 4.2.1)*	*Normal working condition* *(ref. 4.2.1)*	*Deployment/retrieval* *(ref. 4.2.2)*	*Deployment/retrieval* *(ref. 4.2.2)*	*Emergency lift-off* *(ref. 4.2.3)*	*Parked/transit/ survival* *(ref. 4.2.4)*
Self-weight (SW)[1),4)]	100%	SW x (g_0 + MOA)	100% x DF[2)]	g_0 x DF + MOA[2)]	g_0 x DF + MOA[2)]	g_0 + MTA
Live load (LL)	LL = 400 kg/m^2	LL = 400 kg/m^2				
		LL x (g_0 + MOA)				
Live load (applied at the tip of gangway)					F ≥ 600 kg	
					F x (g_0 x 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
Acceptance criteria (ref. 4.3)	I	II	I	II	III	II[3)]

MOA – maximum operational accelerations
MTA – maximum transit/parked accelerations
[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 shall comply with load case II safety requirements.
[4)] Including snow/ice accretion, as applicable.
[5)] Other relevant load cases and/or combinations shall be agreed with DNV GL

4.5 Design loads type 2 gangways

4.5.1

Type 2 gangways shall normally be evaluated based on the load combinations defined in [4.2]. Other design specific loads and load combinations shall be evaluated on a case-by-case basis.

Type 2 specific design requirements:

— Normal working condition: the gangway shall be designed according to the most onerous of the 2 below scenarios:

  — Live load on the gangway shall 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) shall be used for calculations.

— Live load on the gangway tip 120 kg, gangway in uplift/cantilever position.

Guidance note 1:
Length of loaded gangway is the maximum operational length without the safety length.

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The design load shall be 2 x live load.

— Emergency lift-off: Live Load on the gangway tip 350kg (equivalent to a minimum of 2 persons and a person in the stretcher).

Guidance note 2:
Gangway in uplift/cantilever position.

Length of loaded gangway is the maximum operational length without the safety length.

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In addition to the design loads described above, vertical, horizontal (longitudinal/transverse) – "bumper loads" shall be considered depending on the design. These shall be specified by the designer.

4.5.2

Fully motion compensated gangways shall have special consideration.

As a general principle, these shall 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).

In addition, the gangway shall also be calculated for LC 1a and LC 2a in Table 4-5.

Below Table 4-5 summarizes the load combinations and acceptance criteria for type 2 gangways.

Table 4-5 Type 2 - load combinations[6,7)]

		LC 1a	LC 1b	LC 1c	LC 2a	LC 2b	LC 3	LC 4
		Normal working condition (ref. 4.2.1)	*Normal working condition* (ref. 4.2.1)	*Normal working condition* (ref. 4.2.1)	*Deployment/ retrieval* (ref. 4.2.2)	*Deployment/ retrieval* (ref. 4.2.2)	*Emergency lift-off* (ref. 4.2.3)	*Parked/transit/ survival* (ref. 4.2.4)
Self-weight (SW)[1,5)]		100%	g_0 + MOA	g_0 + MOA	100% x DF[2)]	g_0 x DF + MOA[2)]	g_0 x DF + MOA[2)]	g_0 + MTA
Live load (LL)		LL	LL	min. 120kg[4)]				
		2 x LL	2 x LL x (g_0 + MOA)	2 x LL x (g_0 + MOA)				
Live Load (applied at the tip of gangway)							F ≥ 350kg	
							F x (g_0 x DF_Z + MOA)[2)]	
Bumper loads	vertical:	100%, as applicable	100%, as applicable					
	longitudinal:							
	transverse:							
Centrifugal force					100%, as applicable	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
Acceptance criteria (ref. 4.3)		I	II	II	I	II	III	II[3)]

MOA – maximum operational accelerations
MTA – maximum transit/parked accelerations
[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 shall comply with Load Case II safety requirements.
[4)] Gangway in uplift position (cantilever), load applied at the free end (tip).
[5)] Including snow/ice accretion, as applicable.
[6)] Other relevant load cases and/or combinations shall be agreed with DNV GL.
[7)] Fully motion compensated gangways shall have special consideration; Not all load combinations and stress acceptance levels in the table are directly applicable.

SECTION 5 FUNCTIONAL REQUIREMENTS

5.1 General

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

5.2 Walking height

Free walking height shall be a minimum of 2.1 meters

5.3 Clear width

Clear width shall be at least 1.2 meters for type 1 gangways and minimum 0.6 meters for type 2 gangways if not otherwise agreed with DNV GL.

5.4 Walkway

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

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

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

The walkway shall be designed for drainage and easy cleaning of contaminants like mud and oil.

In case of open floorings (e.g. grating), the maximum size of the openings shall 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

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

— Stanchions shall be spaced not more than 1.5 m apart.
— Handrails shall have at least 3 courses. The openings below the lowest course of the handrails shall not exceed 230 mm. The other courses shall be not more than 380 mm apart.

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

Alternative arrangements shall be considered provided that the safety level achieved is similar or higher.

5.6 Access to gangway and waiting area

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

If the gangway is designed with a personnel waiting area attached to or otherwise supported by the gangway, the design load for this area shall be 400 kg/m^2. The design loads for the waiting area shall be considered when evaluating the strength of the main structure of the gangway.

The access to the gangway and/or waiting area (in form of a stairway, a dedicated small gangway/ramp or the gangway itself) shall be designed for a load not less than 400 kg/m^2 (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.

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

Guidance note:

i) 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 (e.g. EN-13586 for type 1 Access, ISO 14122, etc.).

ii) It is recommended that the access to/from the gangway to be ensured by means other than ladders.

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

5.7 Protecting grid

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

The minimum size of the gaps below which the hazard of crushing parts of the human body is considered acceptable shall be calculated based on an internationally recognized standard (e.g. EN 349).

5.8 Lighting

Satisfactory lighting shall be arranged for the entire gangway (including the access to gangway, ref 5.5) and landing platform with stairs, etc. Average illuminance at floor level shall be not less than 100 lux. Illuminance at locations of relative movement between gangway sections, as well as at the ends of the gangway shall be of not less than 300 lux at floor level.

5.9 Landing area

5.9.1 Gangway supported at both ends

For gangways supported at both ends in X, Y, and/or Z axis directions, the landing area shall 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.

Other arrangements shall be agreed with DNV GL.

Guidance note:

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

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Design features to prevent unacceptable movement (e.g. platform, side stoppers, etc.) shall be dimensioned for a design load of twice the resultant loads in X, Y, and Z axis directions at the gangway tip due to:

— gangway self-weight and live loads

— loads due to climatic effects, ref. [4.1.5]

— loads due to motion of the vessel on which the gangway is mounted/supported, ref. [4.1.6].

The gangway shall be fitted with a break-away system (see [6.7]).

5.9.2 Gangway supported at one end only (cantilever)

For gangways designed to operate as a cantilever, the gangway shall be equipped with a system to hold the gangway end in constant position in X, Y and Z axis directions. Tolerance shall not be more than +/- 100 mm unless suitable protection to prevent personal injury is installed.

The function shall not be affected by loss of main/normal power: the functionality shall be ensured through redundancy in the power feeds and HPU pumps.

In addition, the gangway shall 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 [6.10.1.2] to [6.10.1.4].

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

For such gangways, the provisions in sections [5.9.1] and [5.9.2] shall be followed, as applicable.

5.10 Operation angle

5.10.1 General

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

Guidance note:
Steeper operational angles may be considered provided that the deck of the gangway is fitted with treads or steps. This shall be agreed with DNVGL.

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5.10.2 Tread design

All treads shall be securely fitted, and shall extend over the full width of the gangway between the toe boards. Provision should 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 shall not gather between the treads.

— spacing: at regular intervals, not more than 400 mm (in X axis direction)
— height: not less than 30 mm above the walkway.

5.11 Power system

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

The gangway shall 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

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

Electrical installations of DNV GL certified gangways shall comply with DNVGL-RU-SHIP-Pt4Ch8 *Electrical installations*. 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].

The electrical equipment and systems supporting the gangway main functions shall comply with DNVGL-RU-SHIP-Pt4Ch8 *Electrical installations* and will generically be defined as 'essential'. Specifically equipment and systems having impact on the Safety and safety equipment requirements listed in Sec.6 shall fulfil requirements with respect to essential installations.

For gangways onboard mobile offshore units (semi submersibles, jack-ups, etc.), additional requirements as specified by the governing DNVGL rules for classification: Offshore (OU) shall be applied.

Guidance note:
Relevance of the additional requirements may be agreed with DNV GL on a case-by-case basis.

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5.13 Hydraulic systems

5.13.1 General

Hydraulic systems and their lay-out shall satisfy recognized codes or standards and engineering principles and shall, as far as relevant or applicable, comply with pertinent rules of DNV GL.

When designing hydraulic circuits, all aspects of possible methods of failure (including control supply failure) shall be considered. In each case, components shall be selected, applied, mounted and adjusted so that in the event of a failure, maximum safety to personnel shall be the prime consideration, and damage to equipment minimized. (fail-safe concept)

All parts of the system shall 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.

Systems shall be designed, constructed and adjusted to minimize surge pressures and intensification pressures. Surge pressure and intensified pressure shall cause no hazards.

Loss of pressure or critical drops in pressure as well as missing hydraulic refilling shall not cause a hazard.

Leakage (internal or external) shall not to cause a hazard.

Whatever type of control or power supply used (e.g., electrical, hydraulic, etc.), the following actions or occurrences (unexpected or by intention) shall create no hazard:

— switching the supply on or off
— supply reduction
— supply cut-off or re-establishment.

Hydraulic systems and other machinery in connection with the hydraulic system shall be designed to protect personnel from surface temperatures that exceed touchable limits by either insulating or guarding.

To facilitate maintenance, means shall be provided or components so fitted that their removal from the system for maintenance:

— shall minimize the loss of fluid
— shall not require draining of the reservoir
— shall not necessitate extensive disassembly of adjacent parts.

The fluid reservoir shall be designed with respect to:

— dissipation of heat from the oil
— separation of air
— settling of contamination in the oil
— maintenance work.

Indicators showing the fluid level shall be permanently marked with system “high” and “low” levels.

Air breathers on vented reservoirs should 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.

Effective means for filtration and cooling of the fluid shall be incorporated in the system.

A means of obtaining a representative fluid sample shall be provided to allow for checking fluid cleanliness condition.

Valves for fluid sampling shall be provided with sealing and with warning signs marked “system under pressure”.

5.13.2 Flexible hoses

Flexible hoses and couplings shall be of approved type with 3.1 level documentation (type approval certificate issued by DNV GL is recommended).

Flexible hoses shall only be used:

— between moving elements
— to facilitate the interchange of alternative equipment
— to reduce mechanical vibration and/or noise.

Flexible hoses shall be located or protected to minimize abrasive rubbing of the hose cover.

5.13.3 Accumulators

Accumulators shall be separately approved.

5.13.4 Hydraulic cylinders

Load carrying hydraulic cylinders (e.g. luffing cylinders, etc.) shall be separately approved in accordance with DNV standard for certification No.2.9.

Materials for hydraulic cylinders shall fulfil the requirements in DNV standard for certification No. 2.9.

Specific design requirements for hydraulic cylinders to be installed on offshore gangways are listed in [4.3.5.3].

5.13.5 Testing

Except for mountings, each component shall be pressure tested to 1.3 times the design pressure, but not more than 70 bars above the design pressure.

Hydraulic testing of the assembly shall be performed in the presence of a surveyor, unless otherwise agreed. The pressure from the overload testing is deemed sufficient and shall be maintained for a time sufficient for check of leakage. The assembly shall exhibit no sign of defects or leakage.

5.14 Pneumatic systems

Air intakes for compressors shall be so located as to minimize the intake of oil- or water-contaminated air.

When designing pneumatic circuits, all aspects of possible methods of failure (including control supply failure) shall be considered. In each case, components shall be selected, applied, mounted and adjusted so that in the event of a failure, maximum safety to personnel shall be the prime consideration, and damage to equipment minimized. (fail-safe concept.)

Loss of pressure or critical drops in pressure shall cause no hazard.

Leakage (internal or external) shall create no hazard.

Whatever type of control or power supply used, the following actions or occurrences (unexpected or by intention) shall not create a hazard:

— switching the supply on or off
— supply reduction
— supply cut-off or re-establishment.

Air supply to instrumentation equipment shall be free from oil, moisture and other contaminants. The dew point shall be below 5°C for air in pipes located in gangway engine room. In pipes outside the engine room the air shall have a dew point below (T_D-5)°C.

Components requiring extremely clean air shall not be used.

Main pipes shall be inclined relative to the horizontal, and drainages are to be arranged.

Piping and pressure vessels shall comply with relevant recognized codes and shall generally comply with DNV GL Rules.

5.15 Control and monitoring systems

5.15.1 General

Control and monitoring systems components and installations shall comply with DNVGL-RU-SHIP-Pt4Ch9 *Control and monitoring systems*.

Control and monitoring systems supporting the gangway main functions are generically defined as essential according to DNVGL-RU-SHIP-Pt4Ch9. Specifically equipment and systems having impact on the Safety and safety equipment requirements listed in Sec.6 shall fulfil requirements with respect to essential installations.

For gangways onboard mobile offshore units (semi submersibles, jack-ups, etc.), additional requirements as specified by the governing DNVGL rules for classification Offshore (OU) shall be applied.

Guidance note:
Relevance of the additional requirements shall be agreed with DNVGL on a case-by-case basis.

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5.15.2 Wireless remote control systems

Wireless remote control systems shall be specially considered and the requirements agreed with DNV GL.

Guidance for safety and functionality requirements can be found below:

Guidance note:

1) The principles for wireless remote control should be:

   Safe state for the gangway and for the wireless remote control operation should be defined. In general, all over systems should 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.

   Normally we will assume that safe state is immediate stop of all gangway movements. The gangway brake capacities should 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.

   Furthermore:

   — The system should prevent operation if the operator leaves the normal operating area for the gangway. Prevention of this have to be implemented by the gangway-builder
   — The data sent to/from the remote control unit should be subjected to error detection and/or error correction.
   — Transmitting of radio data should also be made possible by "handshaking".

2) The wireless communication with the gangway should not be disturbed by any other external communication signals, and it should be designed in accordance with accepted standards for emission. Radio solutions shall be tested in accordance to ETSI EN 301 489 Electromagnetic compatibility and radio spectrum matters (ERM); ElectroMagnetic Compatibility (EMC) standard for radio equipment and services.
3) 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 should prevent other signals from controlling the gangway movements.
4) Loss of communication with the unique remote control should cause the gangway to go into a safe state as outlined in item 1 above.
5) Additionally, an emergency stop independent of the wireless remote control should be installed. Responsibility of the gangway-builder.
   Furthermore:

   — By starting of the remote control unit a self-check should be conducted in order to prevent movements if the control has been left in such mode.
   — The gangway should also be provided with a hardwired emergency stop easily accessible. Responsibility of the gangway-builder.
   — The remote control unit should be provided with a key-switch for closing when not in use.
   — The remote control unit should also be provided with a "dead man button".

6) The planned operation should 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 should be documented in a detailed analysis (see [6.13]). Responsibility of the gangway-builder.

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5.16 Motion compensating system

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

— Components and installations of the motion compensating system shall comply as a minimum with DNVGL-RU-SHIP-Pt4Ch9 *Control and monitoring systems* where applicable. The motion compensating system shall be generically defined as 'essential' according to DNVGL-RU-SHIP-Pt4 Ch8 and Pt4Ch9.

— Additional certification requirements, as per Table 2-3, shall be applicable.
— Activation of any system with any particular load shall not lead to a hazardous situation.
— No single failure shall lead to a hazardous situation.
— Any failure/fault shall give an alarm at the control station.

SECTION 6 SAFETY AND SAFETY EQUIPMENT

6.1 General

All gangways shall 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.

A series of systems preventing the use of the gangway outside its operational limitations shall 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 shall be provided. The effect of wind and wind gusts in addition to vessel motions shall be considered.

6.3 Protection and precautions against fire

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 shall 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.

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

For gangways operated on board offshore units/installations with hydrocarbon contact (production and drilling units), DNVGL-OS-A101 *Safety principles and arrangements*, Sec.4 *Emergency shutdown (ESD)*, 2.1.4 applies. The gangway manufacturer shall ensure proper fire safety accordingly.

Air pipes from fuel tanks shall be led to open air.

Drip trays shall be arranged at fuel filling pipe.

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

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

Reference is made to DNVGL-RU-SHIP-Pt4Ch3 Sec 1 for fire protection of diesel engines and other combustion engines.

6.4 Operator's cabin

If required or fitted, the cabin shall satisfy the following overall requirements:

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

— noise and vibration shall remain within acceptable limits

Guidance note 1:
It is recommended that noise level is kept under 80dB inside the cabin.

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

Guidance note 2:
It is recommended that the design complies with international recognized standard/code (e.g. EN-13557).

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Gangways shall be arranged with emergency escape in addition to the main access. Portable escape equipment may be accepted.

6.5 Operator in control

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

Type 2 gangways shall 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

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

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

6.7 Break-away system

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

The system shall 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.

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]) shall be made.

The function shall not be affected by loss of main electric power.

6.8 Automatic protection system

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 shall 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.

The system shall 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.

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

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

The function shall not be affected by loss of main/normal power.

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

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

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

6.9 Manual protection system

A manual protection system shall 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 shall 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.

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

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

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

6.10 Generic risk contributors

6.10.1 Overloading

6.10.1.1 General

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

6.10.1.2 Automatic lateral overload protection

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

6.10.1.3 Automatic vertical overload protection

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

6.10.1.4 Automatic axial overload protection

Automatic axial overload protection (in gangway X axis direction, along the gangway) shall 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

6.10.2.1 General

Gangway movements outside operational limits may lead to stress beyond the gangway's structural strength and to operational hazards.

All gangway movements are therefore to be kept within safe operational limitations, either by means of limit devices/alarms or physical layout.

The luffing winches shall 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.

Special consideration shall 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.

Limit devices shall be positively activated and be of failsafe type, i.e. the gangway shall go to a defined safe condition in case of failure (power failure, etc.). Activation of limit devices shall lead to indication in the gangway operator's cabin. After activation of a limiting device, movement in the reverse direction - to a more safe position - shall not be prevented. Where more than one movement causes over-travel, all limit devices limiting such over-travel shall 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.

6.10.2.2 Safety length

For telescopic gangways, the length of the gangway and the arrangement shall 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)

For gangways intended to be installed on assets compliant with the requirements of DNVGL-OS-E301 *Position Mooring*, the safety length of the gangway shall not be less than 1.5 m.

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

6.10.2.3 Safety angle

The gangway shall 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 shall be automatically brought to a safe state (see [6.8]).

6.10.3 Dangerous gangway movements

Dangerous gangway movements or unintentional gangway movements due to malfunction in the gangway's control system may lead to operational risks.

A manually operated emergency stop function, leading to shut-down and stop of the gangway movements, shall therefore be fitted. Simultaneously, the brakes shall be engaged in a progressive and safe manner. The emergency stop shall retain its function regardless of any malfunction in the gangway's control system. Emergency stop actuators shall be located at convenient locations at control station for immediate use by personnel in the event of a hazardous situation occurring.

The emergency stop shall function as, or stopping by:

— immediate removal of power to the machine actuators, or
— mechanical disconnection (declutching) between the hazardous elements and their machine actuators.

The emergency stop shall be so designed that deciding to actuate the emergency stop actuator shall not require the operator to consider the resultant effects (stopping zone, deceleration rate, etc.). The emergency stop command shall over-ride all other commands except the MPS (see [6.9]). The emergency stop function shall not impair the effectiveness of the safety devices or devices with safety related functions. Resetting the control device shall only be possible as the result of a manual action on the control device itself. Resetting the control device shall not cause a restart command.

The emergency stop actuators shall be designed for easy actuation. Types of actuators that may be used include:

— mushroom type push button
— wires, ropes, bars
— handles
— in specific applications, foot pedals without protective cover.

Measures against inadvertent operation shall not impair the accessibility of the emergency stop actuator. The emergency stop actuator shall be coloured red. The background shall be coloured yellow, as far as

practicable. If the emergency stop actuator is not located directly on the machine, labels shall be provided addressing the actuator to the machine. A warning/alarm and an indication in the gangway cabin/on the operator control pod shall inform the gangway operator that the emergency stop has been activated.

6.10.4 Lack of visibility

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).

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 shall be designed with due consideration to environmental factors (wind, salt, moisture, vibrations, etc.) and operational suitability.

6.10.5 Lack of communication

Lack of communication between the gangway operator and the other participants in the gangway operation may lead to operational hazards.

Two-way communication equipment, enabling the gangway operator to communicate with the participants in the gangway operation in a safe way, shall be provided. The gangway operator shall be able to operate the communication system without moving his hands from the main control levers/pod.

6.10.6 Failure in control system

Failure in the gangway's control system may result in unintentional gangway response and movements.

Control system design and components shall therefore be selected, applied, mounted and adjusted so that in the event of a failure, maximum safety shall be the prime consideration (fail-safe concept). All aspects of possible methods of failure – including power supply failure - shall be considered. If any failure occurs, the control system shall always return to the predefined safest condition. Special consideration shall be paid to the below points if subjected to failure in the control system:

— unintended start of machinery shall not be possible
— safety devices or devices with safety related functions shall be impaired to a minimum degree.

An alarm and an indicator revealing any detectable failure in the control system affecting the operation shall be present in the gangway cabin/control pod.

6.10.7 Failure in safety components/system

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

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

6.10.8 Lack of holding/braking capacity

6.10.8.1 Wire luffing gangways

Insufficient braking/holding capacity may lead to uncontrolled gangway movements (falling bridge, etc.).

All driving mechanisms and winches intended for luffing shall be fitted with fail-safe brakes, i.e. failure of the brake's control system shall normally lead to automatic application of the brake.

6.10.8.2 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 shall therefore be designed such a way that missing hydraulic refilling shall not occur. Further, the hydraulic system shall 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

The gangway shall be automatically brought to a safe state if it should lose the support at its tip (see [6.8]).

The loss of support in the landing area shall not cause a sudden drop or fall of the gangway tip.

The function shall not be affected by loss of main/normal power.

6.10.10 Loss of power

Blackout/shutdown may lead to gangway stopping in an unfavorable and unsafe position.

A loss of electric power shall not lead to the gangway becoming inoperable. In the event of loss of main/ normal power an alarm shall be given in a manned control room, local control cabin/pod and vessel Integrated Automation System (IAS).

The gangway shall be connected to an independent emergency power supply, rated to handle the gangway at full 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 shall be of "hold to run" type and clearly and permanently marked for their purpose.

6.10.11 Unintended activation of safety functions

Unintended activation of safety functions may lead to gangway response giving unintentional hazards/risks.

Handling devices for safety functions shall be protected against inadvertent use and positioned away from ordinary operating handles. Interlock devices, preventing inadvertent activation in dangerous zones (water zone only, etc.) shall be fitted when possible.

6.10.12 Spurious trip of safety functions

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.

Consideration to spurious trip shall 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

Activation of safety functions may lead to secondary effects that may be harmful to the gangway and/or the persons operating/crossing it.

Design of safety systems and components shall be done with consideration to dangerous secondary effects. Sector limitations for some safety functions shall be considered.

6.11 Monitoring

Wind speed, vessel acceleration and gangway movement including telescoping distance, slewing and luffing angle shall 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 shall be logged into the system database.

Audible and visual alarms shall 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

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

It shall be installed in various locations along and in the proximity of the gangway.

The alarm system shall 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:

- For normal personnel transferring operations, there shall 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 should also inform personnel on the gangway when it is safe or not to exit the gangway.
- A clearly visible warning alarm comprising of Yellow light and strong acoustic signals shall inform users that the gangway is not yet/anymore safe to be used when:
  - 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.),
  - environmental conditions (e.g. wind speed, vessel accelerations, etc.) escalate to values outside the operating envelope of the gangway
  - 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).
- 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 shall inform the users that the gangway is no longer safe to use.

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

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

6.13 Failure mode effects analysis/failure mode effects and critically analysis

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

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 shall 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 shall be the preferred safety functions and have equal priority, before other safety functions/devices/limiters.

Table 6-1 Monitoring of safety functions

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

6.15 Handling of deviations and extended risks

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

— 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 shall be shown in the submitted documentation.

Further, when the specific safety functions deviates from the generic as specified in [6.10], this shall be agreed with DNV GL.

SECTION 7 PROCEDURAL REQUIREMENTS

7.1 Functional testing of completed gangways

7.1.1 General

Before being put into service for the first time, each completed gangway shall be thoroughly tested to confirm that all the safety, power and control functions are correctly implemented onboard.

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.

In such case, the proposed test plan shall specify the extent of the limited functional testing to be done after final installation (see also [2.2.3] Guidance note)

The functional testing shall be carried out in accordance with the approved testing procedure, which shall be submitted well in advance of the actual testing. The testing procedure shall specify in detail how the respective functions shall be tested and how observations during the test can be ensured. The tests specified below shall be included in the test procedure.

A copy of the approved test procedure shall be kept in the gangway (operational) manual. It shall be completed with final results and endorsed by the competent person.

The significant characteristics of power and braking systems as well as the safety equipment shall be considered. Braking systems and safety equipment shall 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 shall be checked after the installation of the components and during functional testing.

For gangways fitted with systems not included in the below list (e.g. motion compensation system, etc.), additional relevant tests shall be agreed with DNV GL.

Load and functional testing shall be repeated 5 yearly.

In addition, functional testing shall be performed regularly, see App.A.

7.1.2 Prime movers and fluid power systems

Relevant parameters such as power, ambient temperature and pressure, exhaust gas temperature etc. shall be measured and recorded.

Automatic control, remote control and alarm systems connected with power systems shall be tested.

After the test, the lubricating and/or hydraulic oil filters shall be checked for solid particles. Other components of machinery may be required opened up by the surveyor.

7.1.3 Governing and monitoring systems

It shall be verified that control systems function satisfactorily during normal load changes.

Failure conditions or boundary conditions shall be simulated as realistically as possible, preferably letting the monitored parameters pass the alarm safety limits.

7.1.4 Electrical installations

Insulation-resistance test shall be carried out for all outgoing circuits between all insulated poles and earth and, where practicable, between poles. Under normal conditions a minimum value of 1 megaohm shall be obtained. This also applies to instrumentation and communication circuits with voltages above 30V A.C. or D.C.

The insulation resistance of a motor shall not be less than:

$$\frac{3\ x\ rated\ voltage}{rated\ kVA + 1000} megaohms$$

tested on a clean and dry motor when hot.

When found necessary by the surveyor, switchgear shall 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

Brakes shall be tested by braking each motion from maximum speed to full stop. In addition, each brake for the luffing motion shall be tested for three such stops in quick succession during lowering motion.

The emergency stop system shall 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 Table 6-1 as well as the specific safety function requirements as given in the respective discipline sections shall be tested.

7.2 Factory testing

7.2.1 General

Before a gangway is put into service, the following shall be carried out.

The tests shall not cause permanent deformation and the gangway shall not be brought into such a position that it represents danger to persons on the gangway.

All tests shall be held for minimum 15 minutes.

Testing shall be performed according to an approved test procedure.

7.2.2 Bridge load test

Type 1

With the gangway extended to its maximum operational length and supported at both ends, a load test equal to 500 kg/m^2 shall be applied along the gangway.

The total structural deflection of the gangway shall not exceed L/200. The test shall not cause permanent deformation.

Type 2

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 x LL, but not less than 300 kg, shall be applied at the middle of the gangway.

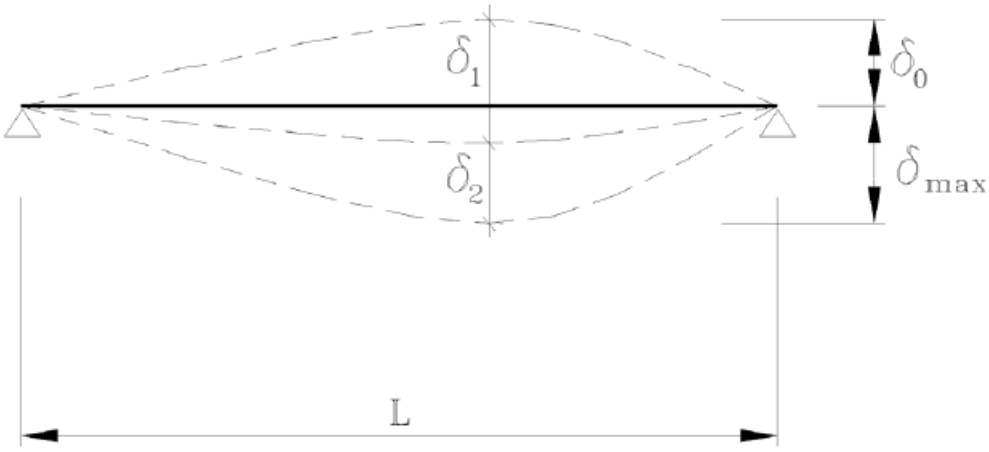
For gangways designed to operate as a cantilever, with the gangway in cantilevered position and extended to its maximum operational length, a test load equal to 1.25 x LL, but not less than 300 kg, shall be applied on the gangway tip.

If a type 2 gangway is designed for a LL higher than 3 persons, the test load distribution along the gangway shall be agreed on a case-by-case basis.

The total deflections shall not exceed the values in Table 7-1. The test shall not cause permanent deformation.

Table 7-1 Condition

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

For cantilever gangways, deflections δ_0, δ_1 and δ_2 shall be measured at the gangway tip (free end).

7.2.3 The gangway in uplift position

7.2.3.1 Gangways designed not to carry people in uplift position

Load test when the gangway is in cantilevered position (simulating lift – off or loss of support at one end) and maximum operational length.

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

$$Test\ load = (\frac{SW\ x\ 0{,}25\ x\ Lg}{L})$$

SW = Self-weight of gangway
Lg = Distance from center of gangway support to the gangway center of Gravity. (m)
L = Maximum operational length (m)

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

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7.2.3.2 Gangways designed to carry people in uplift position

Type 1

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

$$Test\ load\ = (\frac{(SW\ x\ 0{,}25\ x\ Lg) + (F\ x\ Lg)}{L})$$

$F = 500kg/m^2\ x\ L\ x\ w$

L = Maximum operational length (m)

w = Clear width of gangway (m)

Type 2

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

$$Test\ load = \left(\frac{SW\ x\ 0{,}25\ x\ Lg}{L}\right) + F$$

$F = 1.25\ x\ \ maximum\ (\ LL;\ 120kg)$

LL = Live Load (kg)

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

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7.2.4 Slewing system

Slewing system shall be tested for the horizontal design load including design wind load.

The test procedure shall be agreed with DNV GL.

7.2.5 Breakaway system

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

The test procedure shall be agreed with DNV GL.

7.2.6 Telescopic test

Gangways subject to longitudinal bumper loads, a function test proving the pushing capability of the telescopic system shall be performed at 100% of the design push force.

The overload protection of the system shall also be tested.

The test procedure shall be agreed with DNV GL.

7.3 Examination after testing

After testing, the gangway shall 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.

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

7.4 Marking

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

- name of manufacturer
- gangway serial number or similar means of singular identification
- LL - Allowable number of persons (to be marked at both ends of the gangway) – not applicable for type 1 gangways
- clear walking width and height
- operational length of gangway
- operational angles of gangway.

To prevent effacement of the inscriptions, they shall normally be incised, punched or marked.

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

SECTION 8 TYPE 3 GANGWAYS

8.1 General

It is required that type 3 gangways are used according to approved controlled operational procedures, with trained personnel and taking into account the specific functional and safety requirements and limitations of the gangways.

Approval of the above operational procedure shall be performed by a flag/state recognized body.

Generally, a type 2 certified gangway may be accepted provided that it is a cantilever gangway and meets the functional and safety requirements defined in the personnel transfer procedure.

Gangways of more basic design may also be accepted (e.g. fixed length, not operated by hydraulics, fully passive motion compensated, etc.). For such basic designs, the requirements as in the remaining of the section will apply.

8.2 Assumptions

The requirements as given below are based on the following design assumptions:

- People cannot move freely between the connected units; the flow of people is controlled/regulated by the landing and transfer coordinator.
- Connection time: according to the Personnel Transfer Procedure, usually less than 4 hours.
- At least one end of the gangway is supported in the X, Y and Z axis directions.
- The supporting vessel shall contain means moving away the gangway in a safe manner and short time.

8.3 Technical requirements

8.3.1 Design loads

Design loads shall be as per [4.5] (as applicable). Other relevant load cases or conditions shall be agreed with DNVGL.

8.3.2 Functional requirements

Generally, as per Sec.5 with the following amendments:

- [5.8] Lighting – not applicable
- [5.9] Landing area:
  Other arrangements than those defined in [5.9.1] – [5.9.3] may be considered, provided that the safety level achieved is similar or higher.
- [5.10] Operating angle:
  In addition to the requirements in [5.10], the real-time operating angle shall be clearly displayed and positioned so that the Landing and Transfer Coordinator can monitor it at any given time.
  When outside the operating angle range, the Landing and Transfer Coordinator shall decide whether the personnel transferring operation shall continue or be temporarily/permanently suspended.
  Regardless of the operating angle, the gangway shall be fitted with enhanced slip resistance features.
- [5.11] – [5.16] not applicable

8.3.3 Safety and safety equipment

Generally, as per Section 6 with the following amendments:

- *Safety length*

  The gangway operational length shall be correlated with the minimum/maximum distance between the 2 connected vessels and the dimensions of the landing area.

  The minimum/maximum distance between the vessels shall be considered an operational limitation and shall be noted in the gangway certificate.

In addition to the operational length gangways shall have a minimum 3m length reserve in relation to the landing area during operation to accommodate any sudden spacing increase between the 2 connected vessels.

Guidance note:
Depending on how the gangway tip is supported on the landing area, the dimensions of the landing area should be adjusted accordingly.

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— *Monitoring (see [6.11])*

Real-time wind speed, luffing angle, the spacing between the connected vessels, etc. shall be constantly monitored and clearly displayed to the Landing and Transfer Coordinator.

Audible and visual alarms shall be incorporated in the display system and/or gangway proximity to alert Landing and Transfer Coordinator when the wind, vessel and/or Gangway motions go outside pre-defined Operational values.

Cancellation of any triggered alarm shall be manual and only available to the Landing and Transfer Coordinator.

— *Alarm (see [6.12])*

Considering the engineered nature of the entire personnel transfer operation (including possible installation of the gangway, deployment/retrieval and actual personnel transfer), the landing and transfer coordinator, the audible and visual alarms stated in the above monitoring sub-section shall be considered as a minimum.

— *FMEA/FMECA (see [6.13])*

In addition to the FMEA/FMECA of the installed gangway system, a Hazard Identification Analysis (HAZID), as well as a procedure HAZOP for the personnel transferring operation shall be performed to demonstrate that the gangway is safe to use.

These Analyses shall be based on internationally recognized and industry accepted standards for risk management for marine operations (e.g. DNV-RP-H101).

— *Operational limit*

A series of systems and/or design features preventing the use of the gangway outside its operational limitations shall be installed (e.g. overload systems, break-away system, automatic release, etc.).

The gangway shall be designed so that in case of an unexpected event it will not become a truss between the two connected vessels, nor a hazard to the operating personnel.

The generic risk contributors in [6.10] shall be accounted for (as applicable and agreed with DNV GL).

— *Loss of support landing area (see [6.10.9])*

If a crane is used to provide passive support in vertical direction to the gangway during operation, the crane shall be certified as a minimum as a Shipboard Crane for Lifting of Personnel (ref DNV 2.22 Ch.2 Sec.9).

The crane and the gangway pedestal shall be installed on the same ship.

8.3.4 Testing and marking

Testing and marking shall be as per Sec.7 for type 2 gangways (as applicable and agreed with DNV GL).

APPENDIX A RECOMMENDATIONS FOR PERIODIC EXAMINATION, TESTS AND REPAIRS

A.1 General

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

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

A.2 Inspection, tests and repairs

When DNV GL is requested to follow-up the periodical inspection, the following shall be applied.

Gangways shall be periodically examined and tested in accordance with the schedule listed below. The inspector may require other or additional tests and examinations, and dismantling if considered necessary.

National authorities may have stricter requirements for periodical inspections which shall prevail.

Guidance note:
If a gangway has not been in use for more than 6 months and/or has exceeded its periodic inspection date, it shall 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.

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A.3 Annual survey

To be conducted at least once every 12 months (surveys accepted to take place within a time-period ±3 months from the anniversary date of the initial certification/re-certification of the gangway).

Items to be considered for Annual Survey:

- structural condition (cracks, distortions, corrosion). NDT shall be applied when deemed necessary
- support structure
- excessive clearance in sheave-bearings and eye-bolt connections
- wire-rope, including end attachments, with respect to wear, broken wires and corrosion
- operational condition of slewing system (slewing bearing condition, proper lubrication, bolt condition and pretension, etc.)
- operational condition of the telescoping system (including sliding surfaces)
- functional operation
- safety systems and alarms
- leakages in hydraulic system and correct safety valve adjustment
- proper arrangement and condition of electrical systems
- marking (as per test certificates)
- provisions for securing of the gangway during open sea conditions
- fire extinguishing system (sprinkler), if relevant.

A.4 5-yearly survey

To be conducted at least once every 5 years (surveys accepted to take place within a time-period of ±3 months from the anniversary date of the initial certification/re-certification of the gangway).

Items to be considered for the 5-yearly Survey:

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

- Load testing as required for Initial Certification, see [7.2]

— 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.
— 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 DNV GL 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 DNV GL 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.

Holding-down bolts:

— 20% of bolts shall be removed and examined. The initial 20% shall 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 shall be drawn.
— If the first 20% are found to be acceptable and the examination is stopped, a maintenance schedule shall be established for examining the remaining 80% during the 5 years period.
— When refitting, all bolts shall be pre-stressed as stated in the gangway manual or as found on approved drawings.

A.5 Repairs and modifications of gangways

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

The repair shall be noted on the certificate and the repair report shall be attached to the certificate as an Appendix.

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 shall be re-approved, new prototype tests according to Sec.7 may be required and a new certificate shall be issued. The old certificate shall be marked “Deleted” and attached to the new certificate.

DNV GL

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