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1 INTRODUCTION

1.1 Purpose

The purpose of this design basis for mooring system is to outline paramount rules and guidance for planning, performing and document structural design calculations for specific components.

1.2 Definition of terms

Table 1-1. Definition of terms

Term	Definition
NPRA	The Norwegian Public Roads Administration (Statens vegvesen)
ISO	International Organization for Standardization
EC	Eurocode
DNVGL	Det Norske Veritas and Germanischer Lloyd
BV	Bureau Veritas
ROV	Remotely Operated underwater Vehicle
LRFD	Load and Resistance Factor Design
SLS	Serviceability Limit State
ULS	Ultimate Limit State
FAT	Fatigue Limit State (ref. NS-EN 1990)
ALS	Accidental Limit State
MBL	Minimum Breaking Load (characteristic breaking strength of considered component)
DFF	Design Fatigue Factor
DL	Design Life
D	Total Fatigue Damage
F_{life}	Total Fatigue Life
FAT	Fabrication Assembly Test
PBL	Proved Breaking Load
HAT	Highest Astronomical Tide
LAT	Lowest Astronomical Tide
HWL	Highest Water Level
HB	Brinell indentation hardness of material
UV	Ultraviolet radiation

2 BASIS FOR DESIGN

2.1 General

The mooring system including anchors for Bjørnafjorden bridge crossing shall be design for:
- Operation condition
- Accidental condition
- Transport condition
- In-service condition
- Installation condition
- Commissioning condition

All design shall be in accordance with relevant Eurocodes as well as publication N400, ref./1/ and other rules and regulations by the Norwegian Public Road Administration.

All structure and mechanical components of mooring system shall be design according to FOR-2009-07-10-998, ref. /5/ and NS-EN-ISO 19901-7, ref. /6/.

Appropriate standard for sea-fastening, lifting and handling points on mooring components and equipment shall be used for design.

2.2 System of units

For structural design, the ISO International System of Units (SI) is used throughout calculations, documents, design reports and drawings.

2.3 Standards and regulations

In case of conflicts between documents, the following order of precedence shall apply:
- The Norwegian Government rules.
- The Norwegian Public Roads Administration’s requirements.
- National rules and regulations.
- Project specifications.

2.4 Design consideration

According to N400, ref./1/ , the principals of the limit states design method shall be fulfilled.

For mooring system, the following shall be considered and documented:
- Replaceable components shall easily be replaced by using detailed handling and replacement procedure for each component. Replaceable components are to be described in an operation and maintenance manual. The procedures shall identify all necessary equipment required to replace the components.
- Pre-tension and load monitoring the mooring line forces shall be possible and adequate.
- All components of mooring system shall be protected from corrosion or have sufficient corrosion allowance.
- Mooring steel wires shall have adequate surface protection and cathodic protection.
- Mooring fibre rope shall have adequate surface protection and corrosion protection
- Replaceable components on mooring anchors shall have a design so that they can be easily replaced.

- Inspection and measurement below water shall be carried out by ROV (remotely operated underwater vehicle). This includes dimension measurements of chains, measurement of anode potential, condition of anodes, condition of wire ropes and position of anchors.
- Replaceable components under water shall be designed for ROV operation.
- All components are to be assessable for inspection except buried parts of anchors and anchor chains.

2.5 Lay-out description

The components in the mooring system shall be defined and named as follows:

- Chain stopper support
- Chain stopper
- Top chain
- H-link
- Socket
- Mooring line
- Mooring wire, rope or tube
- Bottom chain
- Anchor (gravity, suction, plate or combined skirted-gravity anchors)
- Chain shackle
- Chain swivel
- Anchor support
- Foundation (soil)

2.6 Global co-ordinate system

The global co-ordinate system for the mooring system should be defined and gives reference related to the global co-ordinate system for the bridge. Reference is made to the Design basis - Bjørnafjorden floating bridge, ref./29/.

2.7 Design interfaces and verification limits

The mooring design interface of the support structures at pontoon and anchors shall be defined and the design capacity shall be documented in the design report.

2.8 Limit states

2.8.1 General

The definitions of limit state categories are given in the Design basis - Bjørnafjorden floating bridge, ref./29/.

2.8.2 Minimum breaking load

MBL is an additional limit state that shall be documented for the mooring system. MBL is defined as the characteristic breaking strength of the considered mooring component. The MBL for the support structure and mooring equipment’s shall be documented.

2.8.3 Fatigue

The fatigue design shall be documented in accordance with DNVGL-RP-C203, ref./18/ and data from the Design basis - Bjørnafjorden floating bridge, ref./29/. Design fatigue factor, DFF = 10.0 shall be used for all components.

2.9 Design by LRFD method

According to N400, ref./1/, “Load and Resistance Factor Design” (LRFD) method shall be used.

2.10 Selection of consequence class

Selection of consequence class for various members of mooring system shall be according to the Design basis - Bjørnafjorden floating bridge, ref./29/.

2.11 Minimum design life

The bridge shall be designed for a minimum life time of 100 years (design service life).

Components in the structure that has a design service life, less than 100 years, shall be replaceable and be documented in accordance with regulations.

2.12 Material selection

2.12.1 General

Selection of material shall be in accordance with Handbook R762, ref. /2/.

In general, bolt and fasteners of material type 8.8 quality or similar shall be used for design purpose.

2.12.2 Material quality

All materials shall have material certification in accordance with Handbook R762, ref. /2/ or similar material standards.

The nominal yield strength properties shall be used as characteristic values in the calculations.

2.12.3 Mechanical property

All mechanical properties for material selection to be used for design is only recommended values. Mechanical property data from the manufacture shall documented and verified with the design.

2.12.4 Friction coefficients

Friction coefficients between surfaces shall be included in calculations and documented where it is relevant for the design.

2.12.5 Corrosion allowance

Corrosion and wear allowance for mooring system components shall be based on ISO 19901-7, ref./6/ as given in Table 2-1.

Table 2-1. Corrosion allowance, NS-EN-ISO 19901-7.

Components	Corrosion allowance per year
Top chain	0.8 mm / year
Wire or polyester segment	Sheathed / cathodic protection
Bottom chain	0.2 mm / year
Connection components	0.2 mm / year

2.13 CE marked products

CE certificated type products equipment, components and materials shall be verified and documented according to Handbook R762 and NS-EN 1090.

2.14 Marine growth

Marine growth for mooring lines shall be based on the MetOcean design basis, ref. /30/.

2.15 Classification of cross-sections

Classification of cross-sections shall be in accordance with NS-EN 1993-1-1.

2.16 Ambient temperature

The ambient temperature in air and sea water shall be based on the MetOcean design basis, ref. /30/.

2.17 Permanent load

Permanent loads are the self-weight of the mooring system, with and without content and the equipment installed. Self-weight of planned future tools, equipment, robotics, etc. shall be included and defined as permanent loads.

2.18 Splash zone

Splash zone shall be calculated according to DNVGL-OS-C101, ref. /12/. Reference is made to the Design basis - Bjørnafjorden floating bridge, ref./29/.

2.19 Environmental

Reponses from environmental actions as current, tide, wave, wind loads shall be considered, and loads from the global analysis model shall be used.

2.20 Traffic

Reponses from traffic shall be considered, and loads from the global analysis model shall be used.

2.21 Mooring line load

2.21.1 General

Mooring line loads, from the global analysis model shall be used.

Full coupled time-domain, non-linear and transient analysis, including effects such as vortex shedding, current and out-of-plane bending on mooring lines and components shall be evaluated.

2.21.2 Pre-tension line load

The pre-tension is defined as the line tension at the chain stopper when there are no environmental loads and no traffic loads acting at the bridge.

2.21.3 Operation load

All mooring lines in the system are intact for operation condition. Characteristic loads from line tension (pretension), environmental loads (wind, current, tide and wave) and dynamic line tension due to low-frequency and wave-frequency motions shall be considered for operation conditions.

2.21.4 Accidental load

Ship impact, dropped object, blast and fire loads and impact from submarine slides shall be considered for the mooring system.

2.21.5 Weak link load

A weak link design and/or a maximum line load to fail shall be design and documented to reduce local damage of primary structures.

2.21.6 Bridge deformation and global mooring stiffness

Bridge deformations and global mooring line stiffness shall be considered for the mooring system.

2.22 Foundation

2.22.1 General

The foundation shall be in accordance with Handbook N400, ref./1/. Layout and design of a foundation with high permanent tension and subject to cyclic loads, shall be carried out to achieve necessary safety against global collapse. The required capacity of foundation structure (anchor) and of the foundation soils shall be documented.

2.22.2 Soil

For design of foundation soil (e.g. geotechnical data, seismic parameters, stability, resistance, settlements, displacements etc.), reference is made to the Geotechnical design basis, ref. /31/.

Soil design documentations shall be carried out according to DNVGL-OS-E301, ref./13/. Loads and load factors for design to be used are given in DNVGL-OS-C101, ref. /12/.

The following cases with slope stability analysis for local and global stability of ground in anchoring locations shall be carried out according to methods and provisions provided in the Geotechnical design basis, ref. /31/.

1. Slope over anchoring area
2. Slopes below anchoring areas (with possibility of progressive development of failure towards anchor(s))
3. Dead weight of anchors before hook-up
4. Rockfill under gravity anchors
5. Rockfill as mitigation measure around anchors

If anchors are placed in locations susceptible to submarine slides and are critical to minimum redundancy requirement of anchoring system, then these anchors shall be designed for impact loads from the submarine slides for all possible loading and failure mechanisms. For specific requirements related to landslide dynamics reference is made to the Geotechnical design basis, ref. /31/.

Preliminary general criteria for various types of anchors in relation to necessary soil thickness and maximum allowable seabed slope for each anchor type in Table 2-2. It must be noted that this is only preliminary criteria and can be subjected to change as the location specific anchor stability analyses and assessments proceed.

Table 2-2. Summary of limiting conditions used in general screening for the different anchor types.

Anchor type	Maximum seabed slope [deg]	Soil thickness [m]
Suction anchors	< 10	> 10
Gravity anchors	< 5	< 10
Combined anchors	< 5	< 20
Plate anchors	< 10	> 10

Apart from traditional anchor types, combination of these anchor types can also be used. The base-case anchor types are gravity, suction, combined (skirted gravity anchor) or plate anchors.

Specific requirements for different types of anchors are given in Section 2.22.3 and Section 5.8.

2.22.3 Anchor

The anchor (foundation structure), including the anchor padeye, shall be designed for the loads in the Design basis - Bjørnafjorden floating bridge, ref./29/. Acceptance and design criteria are specified in DNVGL-OS-E301 ref./13/ and DNVGL-OS-C101, ref. /12/.

Anchors shall be design for both static and dynamic loads, where loss of post-tensioning due to creep in structural material or soil shall be considered. Anchors shall be designed for various relevant limit states as defined in Design basis – Bjørnafjorden floating bridge ref./29/.

The following installation tolerances prescribed for anchors shall be considered in calculations:

- Position (tolerance radius) = ± 5 m
- Orientation (heading) = 0 – 5 degrees
- Verticality = ± 5 degrees

In addition to above defined tolerances anchor installation with block(s) in sediments (up to 0.5 m diameter) shall also be checked.

Specific requirements for different types of anchors are given in Section 5.8.

3 DESIGN CONDITIONS

3.1 Operation condition

Handbook N400, ref. /1/ shall be used as basis for the operation condition. Design safety factors from FOR-2009-07-10-998 Ankringsforskriften", ref./5/ shall be used.

The bridge shall be designed to operate with two line damaged or out of service for 2 years for every 25 years life time.

The mooring system shall be passive and no line tension adjustment should take place during operation.

Fatigue damage during operation must be included in the total damage evaluation.

3.2 In-service condition

3.2.1 General

Handbook R762, ref./2/ and Handbook V441, ref. /4/ shall be used as basis for in-service maintenance and inspection of the mooring system.

3.2.2 Management, operation and maintenance

An operation and maintenance manual is to be established, giving a general description of the system, measurements and inspection to be carried out. This includes schedule for the inspections and procedures for replacement of components. The manual should contain plans for how the inspection shall be carried out, equipment to be used (e.g. required ROV tools), and how the inspection data shall be recorded for future reference. The inspection plan should aim to target potential failure mechanisms and critical areas of the design. Acceptance criteria based on the design assumption shall be developed and included.

DNVGL-RU-OU-0102, ref./25/ gives basic guidelines for in-service inspection of floating vessels.

3.2.3 Adjustment of mooring line tension

Even though the mooring system is passive and no line tension adjustment should take place during the lifetime, adjustment of the mooring lines shall be able after the installation. For a condition where one line is out-of-service, with a line breakage, or where long term anchor creep occurs, the mooring line shall be designed to accomplish favourable pre-tension load for the system. All mooring lines shall be replaceable.

3.2.4 Monitoring and measurement

The mooring line system shall be equipped with mooring line tension measurement and monitoring system and with a line failure detection system. This may be different system. The mooring line tension measurement system is assumed to be operating for a limited time period (minimum 5 years) to confirm the line tension calculations. The design of the line monitoring system should be adequate for a life period of 25 years.

3.2.5 Above water inspection

For above water inspection Handbook V441 shall be used. All fatigue exposed areas above water shall have access for visual and non-destructive inspection (NDT).

3.2.6 Below water inspection

The below water inspection and maintenance shall be carried out by ROV. This includes dimension measurements of the chain, measurements of anode potential, condition of a nodes, and general condition of the wire rope and position of anchors.

3.2.7 Replacement

Detailed procedures for replacement of all replaceable components shall be developed and included in the management, operation and maintenance manual. The procedures shall identify all necessary equipment required to replace the components.

Replaceable components under water shall be designed for ROV operation.

3.3 Fabrication and assembly condition

3.3.1 General

NS-EN 1090, ref. /9/gives requirements for production and fabrication of steel structures. Technical requirements for fabrication of steel structures are given in NS-EN 1090-2.

3.3.2 Fabrication assembly test

Particular care shall be taken for handling of the mooring components during the fabrication and installation phase. This require a fabrication assembly test where design of jigs / cradles and other rigging may be used to prepare the installation in advance.

3.4 Installation condition

3.4.1 General

FOR-2009-07-10-998 Ankringsforskriften", ref./5/ gives requirements to installation and handling of the mooring system.

3.4.2 Designer requirement

The designer of the system shall in addition to design, establish general guidelines for installation including acceptance criteria to ensure that the installation is carried out according to the design assumptions. Detailed procedures are to be prepared by the installation contractors based on the designer guideline.

3.4.3 Contractor requirement

The installation of the mooring system shall be carried out by a qualified installation contractor with a proven track record and documented capabilities including documentation of the equipment intended to use. The installation shall be carried out according to approved installation procedures in agreement with the designer.

3.4.4 Survey requirement

The installation shall be surveyed by experienced personnel to ensure that the mooring system is installed according to the design assumptions and within the specified acceptance criteria. Damages and minor flaws occurring, during the installation (e.g. minor tears in wire sheathings) shall be recorded, assessed and even if found acceptable at the time of installation be recorded for further in-service follow-up.

3.5 Transportation and handling condition

Sea transportation and handling of mooring components from the fabrication yard to the installation field shall be documented.

Fatigue damage during transportation shall be included when calculating the total damage.

3.6 Accidental condition

ALS conditions as defined in Design basis - Bjørnafjorden floating bridge, ref./29/. shall be included in the calculation.

4 DESIGN CRITERIA

4.1 General

The general requirements for the design shall be in accordance to Handbook N400, ref./1/.

In general, partial factors from Eurocode standards shall be used where application and type of construction is adequate for design purpose.

The actions are to be combined in the most un-favourable way, provided the combination is physically feasible and permitted.

4.2 Design safety factor

The mooring system shall be designed with safety factors in NS-EN-ISO 19901-7, Table B.2 for consequence class 3. Design safety factor includes multiplication of all load, material, fabrication and geometric safety factors.

4.3 Load combinations

The load combinations shall be based on NS-EN 1990, ref./8/ and specified load combinations in the Design basis - Bjørnafjorden floating bridge, ref. /29/ shall be used and documented.

Support structure and mooring equipment's as winch, chain stopper etc. shall be designed and documented by using the MBL criteria in FOR-2009-07-10-998.

For load combinations where line failures are considered, conservative assumption shall be made, where the remaining capacity of the global structure must be documented for 100 years environmental conditions. Load combination with minimum two mooring line failure for each cluster shall be documented.

4.4 Material

4.4.1 General

All material shall fulfil requirements in Handbook R762, ref. /2/.

The actual hardness of carbon and bolt material steel should not exceed 300 HB.

4.4.2 Yield strength criteria

For non-compliance structure, yield strength criteria from NS-EN 1993-1-1 and partial factors from NS-EN 1993-2 shall be used.

4.4.3 Plastic strain criteria

Based on Eurocode standards, some components which are not under constant loading and evaluated as none critical for maintaining the functionality of the system are permitted to be designed for plastic yielding. Although yielding is allowed in these components, the components safety against fracture must be ensured by using total strain criteria of 5.0 % for an elastic-plastic material. The strain criteria shall include all fabrication imperfections and misalignments in all connections. All design safety factors (material and load factors, etc.) shall be included as safety factor or reduction factor when plastic strain criteria is used.

4.5 Global model

The global analysis method is to be a fully coupled time-domain analysis following the guidelines in ISO 19901-7, DNV-GL-OS-E301 and recommended practice in DNV-RP-F205. Non-linear and transient effects are to be evaluated. References to which global analysis models and results that are used for documentation of the mooring system shall be given in the design report.

The analyses shall be performed with respect to SLS, ULS (& FAT) and ALS.

4.6 Local detail

4.6.1 General

Verification of strength capacity locally, including local effects such as vortex shedding, current and plane bending effects of mooring components and details are to be evaluated.

FAT and MBL conditions shall be included in the calculation.

4.6.2 Fatigue due to in-plane and out-of-plan bending

Guidance note, BV NI-604-DT-R00-E, ref. /27/ provides methodologies, requirements and recommendations to be considered for the top chain. Tension and pre-tension loads from the global analysis model shall be used to document the fatigue life of the chain due to in-plane / out-of-plane bending.

4.7 Temporary phases

4.7.1 General

DNVGL-ST-N001, ref. /27/ shall be used as the governing standard for temporary phases.

Temporary phases include transportation and marine operations. Marine operations in this context are non-routine operations of a limited duration for handling of an object offshore, inshore and at shore.

4.7.2 Marine operations

Marine operations are normally related to handling of an object during temporary phases from or at the yard site or construction site to the final destination or installation site. Marine operations shall be categorized either as weather-restricted or weather-unrestricted. Typical activities are load transfer operations, transport and handling from sea-surface.

The sea-fastening of mooring components shall be fit for transportation activity and documented by a suitable standard.

Fatigue is normally not governing for design with operations of short duration. However, for unconventional transportation of components it should be investigated if there are any effects causing fatigue.

ULS and FAT conditions shall be included in the calculation.

4.7.3 Lifting and installation

Hang-off, lifting lugs and lifting arrangement shall be documented according to suitable standard. Special consideration shall be made when components are lifting through the water splash zone.

If mooring components are located on a vessel at sea for a long period, fatigue assessment shall be evaluated and accounted for when calculating the fatigue damage.

ULS and MBL conditions shall be included in the calculation.

4.7.4 In-service and replacement

The bridge shall be designed to operate with one line damaged or out of service for 2 years. Traffic loads and environmental loads shall be considered for this condition.

Fatigue is normally not governing for operations of short duration. However, for unconventional replacement situations of components it should be investigated if there could be any effects causing fatigue.

ULS and FAT conditions shall be included in the calculation.

5 REQUIREMENTS

5.1 General

General technical requirements of equipment and mooring line components are defined in FOR-2009-07-10-998 “Ankerforskriften”, ref. /5/ and DNV-GL-OS-E301, ref. /13/.

NS-EN 1090, ref. /9/gives requirements for execution and manufacture of steel structures. Technical requirements for fabrication of steel structures are given in NS-EN 1090-2.

NS-EN ISO 12328, ref. /7/ gives general requirements, recommendations and overall guidance for design of facilities below sea surface.

All components shall be designed for a lifetime of minimum 50 years and a preferable lifetime of 100 years. The components are to be protected by a combination of coatings, cathodic protections and corrosion allowances. Easy replaceable wear parts shall have a lifetime of minimum 25 years.

5.2 Mooring system

DNV-GL-OS-E301, ref. /13/ shall be used for design and manufacture of mooring systems.

5.3 Steel wire ropes

DNV-GL-OS-E304, ref. /16/ shall be used for design and manufacture of steel wire ropes.

Steel wire ropes are to be sheathed and protected from corrosion or having sufficient corrosion allowance. The wire rope socket shall be protected by a combination of coating and cathodic protection. The steel wire rope shall be electrically isolated from the socket, or the socket shall be isolated from the adjacent component.

5.4 Fibre ropes

DNVGL-OS-E303, ref. /15/ shall be used for design and manufacture of fibre ropes.

Fibre ropes are to be sheathed and special consideration to achieve sufficient protection over the design life shall be documented. The effect of UV light, seawater (hydrolysis resistance), etc., intensity during conditions (transport, storage, operation, design life, etc.) shall be stated in the fibre rope documentation.

5.5 Steel tubes

DNVGL-ST-F201, ref. /17/ should be used for design and manufacture of steel tube mooring.

5.6 Mooring chains

DNV-GL-OS-E302, ref. /14/ shall be used for design and manufacture of mooring chain and accessories.

5.7 Mooring equipment

FOR-2009-07-10-998, ref. /5/ shall be used for design and manufacture of mooring equipment. Mooring equipment includes winches, chain stoppers, latches, swivels, pals, etc.

Other mooring equipment not mentioned in FOR-2009-07-10-998 shall be design and manufactured according to DNVGL-OS-E301, ref. /13/.

5.8 Anchors

5.8.1 General

The anchors shall be designed for min. 100 years service life. For components, which are easily replaceable, a min. design life of 25 years may be considered. There are four types of anchors that may be suitable for Bjørnafjorden.

- Suction anchor
- Gravity anchor
- Plate anchor
- Combined anchor (skirted-gravity anchor)

All anchor types shall be designed in accordance with offshore standards DNVGL-OS-C101, ref. /12/ and DNVGL-OS-E301, ref./13/ and shall be fabricated according to requirements given in Handbook R762 ref./2/ and NS-EN 1090 ref./9/.

Additional fatigue assessment of anchors shall be performed according to recommended DNVGL standards.

5.8.2 Suction anchor

Design of suction anchors shall be carried out according to DNVGL-RP-E303, ref./21/.

In the calculation of the anchor resistance, strength anisotropy and the effects of cyclic loading on the undrained shear strength shall be accounted for. The characteristic undrained shear strength shall be taken as the mean value with due account of the quality and complexity of the soil conditions.

Settlements under the suction anchors in relation to allowable deformations in anchoring system shall be studied. Lateral creep deformation in soil due to permanent horizontal post-tension load shall be studied to a level necessary for concept verification phase.

5.8.3 Gravity anchor and combined anchor

Design of gravity anchor shall be carried out according to DNVGL-OS-E301, ref./13/ and DNVGL-OS-C101, ref. /12/.

This applies to anchors which rely on their self weight to provide resistance to vertical, lateral and torsional loading. Gravity anchors may be provided with skirts which penetrate the seabed to provide increased lateral resistance through mobilization of additional seabed strata.

Self-settlements in filling under gravity anchors in case of gravity anchors are founded on a stone filling shall be taken into account.

For under water filling on rock surface maximum filling slope angle shall be 1:3. Filling over sloping underwater rock surface and filling over clay sediment shall be checked for short-term and long-term stability.

5.8.4 Plate anchor

Design of plate anchors shall be carried out according to DNVGL-RP-E302, ref./20/.

In the calculation of the anchor resistance, strength anisotropy and the effects of cyclic loading on the undrained shear strength shall be accounted for. The characteristic undrained shear strength shall be taken as the mean value with due account of the quality and complexity of the soil conditions.

Lateral creep deformation in soil (due to permanent horizontal post-tension load) shall be studied to a level necessary for concept verification phase.

5.9 Bearings

Self-lubricated bearings with double water tighten sealing shall be used for marine and sea water applications.

6 REFERANCE

Table 6-1. Provided rules, regulations, standard and documentation

Ref.	Description
/1/	Håndbok N400 Bruprosjektering, 2015
/2/	Håndbok R762 Prosesskode 2, 2015
/3/	Håndbok V220 Geoteknikk i vegbygging, 2014
/4/	Håndbok V441 Inspeksjonshåndbok for bruer, 2014
/5/	FOR-2009-07-10-998 Ankringsforskriften 09
/6/	NS-EN ISO 19901-7 Dynamisk posisjonering og forankring av flytende innretninger og flyttbare innretninger til havs, 2013
/7/	NS-EN ISO 13628 Petroleum and natural gas industries – Design and operation of subsea production systems
/8/	NS-EN 1990 Eurokode: Grunnlag for prosjektering av konstruksjoner, 2016
/9/	NS-EN 1090 Utførelse av stålkonstruksjoner og aluminiumkonstruksjoner, 2011
/10/	NS-EN 1993 Eurokode 3: Prosjektering av stålkonstruksjoner
/11/	NS-EN 1993-2 Prosjektering av stålkonstruksjoner, Del 2: Bruer, 2009
/12/	DNVGL-OS-C101 Design of offshore steel structures, general LRFD method, 2016
/13/	DNVGL-OS-E301 Position mooring, 2015
/14/	DNVGL-OS-E302 Offshore mooring chain, 2015
/15/	DNVGL-OS-E303 Offshore fibre ropes 2016
/16/	DNVGL-OS-E304 Offshore mooring steel wire rope, 2015
/17/	DNVGL-ST-F201 Dynamic risers, 2018
/18/	DNVGL-RP-C203 Fatigue Design of Offshore Steel Structures, 2016
/19/	DNVGL-RP-E301 Design and installation of fluke anchors, 2017
/20/	DNVGL-RP-E302 Design and installation of plate anchors in clay, 2017
/21/	DNVGL-RP-E303 Geotechnical design and installation of suction anchors, 2017
/22/	DNVGL-RP-E304 Damage assessment of fibre ropes for offshore mooring 2017
/23/	DNVGL-RP-E305 Design, testing and analysis of offshore fibre ropes, 2015
/24/	DNVGL-RP-F205 Global performance analysis of deepwater floating structure, 2017
/25/	DNVGL-RU-OU-0102 Floating production storage and loading unit, 2016
/26/	DNVGL-ST-E273 2.7-3 Portable offshore units, 2016
/27/	BV NI-604-DT-R00-E Fatigue of top chain of mooring lines due to in-plane and out-of-plane bendings, 2014
/28/	2017-02-01 Møte med Sjøfartsdirektoratet – Permanent oppankring og erfaring fra innrettinger på norsk sokkel, rev 01
/29/	SBJ-32-C4-SVV-90-BA-001 rev.0 Design basis – Bjørnafjorden floating bridge
/30/	SBJ-01-C3-SVV-01-BA-001 rev.0 Design basis – MetOcean
/31/	SBJ-02-C4-SVV-02-RE-004 rev.0 Design basis – Geotechnical design