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Mechanical equipment

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Mechanical equipment

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Introduction

The standard has been considerably updated on most parts due to the long period since last update. This is also related to updates on relevant standards and directives. Completely new clauses added are e.g. exhaust systems and WHRU's, and electrical motors and generators.

Foreword

NORSOK R-001:2017, was adopted as NORSOK Standard in January 2017.

NORSOK R-001:2017, replaces NORSOK R-001, rev. 3, November 1997.

NORSOK is an acronym for the competitive position of the Norwegian continental shelf and comprise petroleum industry standards in Norway. The collaboration initiative in 1993 between the authorities and the petroleum industry initiated the development of NORSOK standards.

Reducing the project execution time and developing and operating cost for petroleum installations on the Norwegian shelf was the target.

The intention for the Petroleum industry is to develop and use standards providing good technical and cost effective solutions to ensure that the petroleum resources are exploited and managed in the best possible way by the industry and the authorities. The industry will actively contribute to the development and use of international standards in the global market.

The NORSOK standards shall:

- Bridge the gap based on experiences from the Norwegian continental shelf where the international standards are unsatisfactorily;
- replace oil company specifications where possible;
- be available as references for the authorities' regulations;
- be cost effective;
- promote the Norwegian sector as an attractive area for investments and activities.

Developing new NORSOK standards and regular maintenance of existing standards shall contribute to maintain the competitiveness both nationally and internationally for the Norwegian petroleum industry.

The NORSOK standards are developed by experts from the Norwegian petroleum industry and approved according to the consensus principles as laid down by the guidelines given in NORSOK directive, A-001.

The NORSOK standards are owned by the Norwegian Oil and Gas Association, the Federation of Norwegian Industries and the Norwegian Shipowners' Association. They are managed and published by Standards Norway.

Annexes A is informative.

1 Scope

This standard describes technical requirements for the design, manufacturing, assembling, product inspection, and installation and testing of mechanical equipment, except lifting equipment.

The requirements of this standard and the relevant data sheets of annex A are covering the mechanical requirements of the following equipment categories:

Pumps, compressors, gas turbines, reciprocating combustion engines, transmissions, expanders, steam turbines, lubrication and seal oil systems, base plates, centrifuges, cyclones, pressure retaining equipment (incl. heat exchangers, etc.), atmospheric tanks, electric motors and generators.

2 Normative references

The following standards include provisions which, through reference in this text, constitute provisions of this NORSOK standard. Latest issue of the references shall be used unless otherwise agreed. Other recognized standards may be used provided it can be shown that they meet or exceed the requirements of the standards referenced below.

2.1 General references

94/9/EU, *Equipment and Protective Systems Intended for Use in Potentially Explosive Atmospheres*

2014/68/EU, *Pressure Equipment Directive*

2006/42/EC, *Machinery Directive*

2014/34/EU, *ATEX Directive*

API Std 670, *Machinery Protection Systems*

API RP 686, *Machinery Installation and Installation Design*

ASME B1.20.1, *Pipe Threads, General Purpose, Inch*

ASME B16.5, *Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard*

ASME B16.47, *Large Diameter Steel Flanges: NPS 26 through NPS 60 Metric/Inch Standard*

ASME B31.3, *Process Piping*

ISO 228-1, *Pipe threads where pressure-tight joints are not made on the threads – Part 1: Dimensions, tolerances and designation*

ISO 1940-1, *Mechanical Vibration – Balance quality requirements of rigid rotors – Part 1: Specification and verification of balance tolerances*

ISO 9614-2, *Acoustics – Determination of sound power level of noise sources using sound intensity – Part 2: Measurement by scanning*

ISO 21940-12, *Mechanical vibration -- Rotor balancing -- Part 12: Procedures and tolerances for rotors with flexible behaviour*

NORSOK L-001, *Piping and valves*

NORSOK L-002, *Piping system layout, design and structural analysis*

NORSOK L-CR-003, *Piping details*

NORSOK L-004, *Piping fabrication, installation, flushing and testing*

NORSOK M-001, *Materials selection*

NORSOK P-002, *Process system design*

NORSOK R-002, *Lifting equipment*

NORSOK R-003, *Safe use of lifting equipment*

NORSOK R-005, *Safe use of lifting and transport equipment in onshore petroleum plants*

NORSOK S-001, *Technical safety*

NORSOK S-002, *Working environment*

NORSOK Z-006, *Preservation*

2.2 Pumps

ANSI/AGMA 9003-A91, *Flexible Couplings – Keyless Fits*

API Std 610, *Centrifugal Pumps for Petroleum, Petrochemical and Natural Gas Industries*

API Std 674, *Positive Displacement Pumps – Reciprocating*

API Std 675, *Positive Displacement Pumps-Controlled Volume for Petroleum, Chemical, and Gas Industry Service*

API Std 676, *Positive Displacement Pumps-Rotary*

API Std 682, *Pumps-Shaft Sealing Systems for Centrifugal and Rotary Pumps*

API Std 685, *Sealless Centrifugal Pumps for Petroleum, Petrochemical, and Gas Industry Process Service*

DIN 7190, *Interference fits - Calculation and design rules*

ISO 5199, *Technical specifications for centrifugal pumps – Class II*

ISO 13709, *Centrifugal pumps for petroleum, petrochemical and natural gas industries*

ISO 13710, *Petroleum, petrochemical and natural gas industries – Reciprocating positive displacement pumps*

2.3 ISO 15783, Seal-less rotodynamic pumps – Class II – SpecificationCompressors

API Std 617, *Axial and Centrifugal Compressors and Expander-compressors*

API Std 618, *Reciprocating Compressors for Petroleum, Chemical, and Gas Industry Services*

API 619, *Rotary-Type Positive-Displacement Compressors for Petroleum, Petrochemical, and Natural Gas Industries*

ASME PTC 10, *Performance Test Code on Compressors and Exhausters*

ISO 10439-1, *Petroleum, petrochemical and natural gas industries – Axial and centrifugal compressors and expander-compressors – Part 1: General requirements*

ISO 10439-2, *Petroleum, petrochemical and natural gas industries – Axial and centrifugal compressors and expander-compressors – Part 2: Non-integrally geared centrifugal and axial compressors*

ISO 13631, *Petroleum and natural gas industries – Packaged reciprocating gas compressors*

ISO 13707, *Petroleum and natural gas industries – Reciprocating compressors*

ISO 10440, *Petroleum, petrochemical and natural gas industries – Rotary-type positive-displacement compressors*

2.4 Gas turbines

API Std 616, *Gas Turbines for the Petroleum, Chemical, and Gas Industry Services*

ASME PTC 22, *Performance Test Code on Gas Turbines*

ISO 21789, *Gas turbine applications – Safety*

2.5 Reciprocating combustion engines

DNV GL, *Rules for Classification of Ships*

ISO 3046-1, *Reciprocating internal combustion engines – Performance – Part 1: Declarations of power, fuel and lubricating oil consumptions, and test methods – Additional requirements for engines for general use*

ISO 3046-3, *Reciprocating internal combustion engines – Performance – Part 3: Test measurements*

ISO 3046-4, *Reciprocating internal combustion engines – Performance – Part 4: Speed governing*
ISO 3046-5, *Reciprocating internal combustion engines – Performance – Part 5: Torsional vibrations*
ISO 3046-6, *Reciprocating internal combustion engines – Performance – Part 6: Overspeed protection*
ISO 6798, *Reciprocating internal combustion engines – Measurement of emitted airborne noise – Engineering method and survey method*
ISO 10816, *Mechanical vibration – Evaluation of machine vibration by measurements on non-rotating parts (all parts of standard)*

2.6 Transmissions

ANSI/AGMA 9003-A91, *Flexible Couplings – Keyless Fits*
API Std 613, *Special Purpose Gear Units for Petroleum, Chemical and Gas Industry Services*
API 671, *Petroleum, petrochemical and natural gas industries – Flexible coupling for mechanical power transmission – Special purpose applications*
API Std 677 (R2010), *General-Purpose Gear Units for Petroleum, Chemical and Gas Industry Service*
DIN 740-1, *Power Transmission Engineering Flexible Shaft Couplings; technical delivery conditions*
DIN 740-2, *Power Transmission Engineering Flexible Shaft Couplings; parameters and design principles*
DIN 7190, *Interference fits - Calculation and design rules*
ISO 6336, *Calculation of load capacity of spur and helical gears (all parts of standard)*
ISO 10441, *Petroleum, petrochemical and natural gas industries – Flexible coupling for mechanical power transmission – Special purpose applications*
ISO 13691, *Petroleum and natural gas industries – High-speed special-purpose gear units*
ISO 14691, *Petroleum, petrochemical and natural gas industries – Flexible couplings for mechanical power transmission – General-purpose applications*

2.7 Expanders

ASME PTC 10, *Performance Test Code on Compressors and Exhausters*
API Std 617, *Axial and Centrifugal Compressors and Expander-compressors*
ISO 10439-1, *Petroleum, petrochemical and natural gas industries – Axial and centrifugal compressors and expander-compressors – Part 1: General requirements*

2.8 Steam turbines

API Std 612, *Petroleum, Petrochemical, and Natural Gas Industries – Steam Turbines – Special-purpose Applications*
ISO 10437, *Petroleum, petrochemical and natural gas industries – Steam turbines – Special-purpose applications*

2.9 Lube, seal oil and seal gas support systems

API 614, *Lubrication, shaft-sealing and oil-control systems and auxiliaries*
API 692, *Dry Gas Sealing Systems (relevant when issued)*
ISO 4406, *Hydraulic fluid power – Fluids – Method for coding the level of contamination by solid particles*
ISO 10438-1, *Petroleum, petrochemical and natural gas industries – Lubrication, shaft-sealing and control-oil systems and auxiliaries: – Part 1: General requirements*
ISO 10438-2, *Petroleum, petrochemical and natural gas industries – Lubrication, shaft-sealing and control-oil systems and auxiliaries: – Part 2: Special-purpose oil systems*
ISO 10438-3, *Petroleum, petrochemical and natural gas industries – Lubrication, shaft-sealing and control-oil systems and auxiliaries: – Part 3: General-purpose oil systems*

ISO 10438-4, *Petroleum, petrochemical and natural gas industries – Lubrication, shaft-sealing and control-oil systems and auxiliaries: – Part 4: Self-acting gas seal support systems*

2.10 Base plates

0027/ND, *Guidelines for marine lifting operations*

DIN 4024-1, *Machine foundations; Flexible structures that support machines with rotating elements*

DNV No. 2.7-3, *Portable Offshore Units – DNV Standards for Certification*

DNV-OS-H101, *Marine Operations, General – DNV Offshore Standards*

DNVGL-RP-0005, *RP-C203: Fatigue design of offshore steel structures*

EN 1993, *Eurocode 3: Design of Steel Structures*

NORSOK M-101, *Structural steel fabrication*

NORSOK M-120, *Material data sheets for structural steel*

NORSOK N-001, *Integrity of offshore structures*

NORSOK N-004, *Design of steel structures*

2.11 Pressure retaining equipment

API Std 530, *Calculation of heater-tube thickness in petroleum refineries*

API RP 534, *Heat recovery steam generators*

API Std 560, *Fired heaters for general refinery services*

ASME VIII, *Boiler and Pressure Vessel Code*

EN 1990, *Eurocode – Basis of structural design*

EN 1090-2, *Execution of steel structures and aluminium structures – Part 2: Technical requirements for steel structures*

EN 1993, *Eurocode 3: Design of Steel Structures*

EN 12953, *Shell boilers – Part 1: General*

EN 13445, *Unfired pressure vessels*

EN 14359, *Gas-loaded accumulators for fluid power applications*

ISO 13704, *Petroleum, petrochemical and natural gas industries – Calculation of heater-tube thickness in petroleum refineries*

ISO 13705, *Petroleum, petrochemical and natural gas industries – Fired heaters for general refinery services*

ISO 15547-1, *Petroleum, petrochemical and natural gas industries – Plate-type heat exchangers*

PD 5500, *Specification for unfired fusion welded pressure vessel code*

TEMA, *Tubular Exchanger Manufacturers Association*

2.12 Atmospheric tanks

EN 1990, *Basis of structural design*

EN 1090-2, *Execution of steel structures and aluminium structures – Part 2: Technical requirements for steel structures*

EN 1993, *Eurocode 3: Design of Steel Structures*

EN 13923, *Filament-wound FRP pressure vessels – Materials, design, manufacturing and testing*

EN 13121, *GRP tanks and vessels for use above ground*

2.13 Documentation for maintenance/operation

NORSOK Z-001, *Documentation for operation DFO*

NORSOK Z-018, *Supplier's documentation of equipment*

2.14 Electric motors and generators

API Std 541, *Form-wound Squirrel-Cage Induction Motors – 500 Horsepower and Larger*

API Std 546, *Brushless Synchronous Machines – 500 kVA and Larger*

API Std 547, *General-purpose Form-wound Squirrel Cage Induction Motors – 250 Horsepower and Larger*

BS 5000-3, *Rotating electrical machines of particular types or for particular applications. Generators to be driven by reciprocating internal combustion engines. Requirements for resistance to vibration*

IEC 60034-1, *Rotating electrical machines – Part 1: Rating and performance*

IEC 60034-14, *Rotating electrical machines – Part 14: Mechanical vibration of certain machines with shaft heights 56 mm and higher – Measurement, evaluation and limits of vibration severity*

IEC 61892-3, *Mobile and fixed offshore units – Electrical installations – Part 3: Equipment*

ISO 1940-1, *Mechanical vibration – Balance quality requirements for rotors in a constant (rigid) state – Part 1: Specification and verification of balance tolerances*

ISO 8528-9, *Reciprocating Internal Combustion Engine Driven Alternating Current Generating Sets – Part 9: Measurement and evaluation of mechanical vibrations*

NORSOK E-001, *Electrical systems*

3 Definitions and abbreviations

3.1 Definitions

3.1.1

can (possibility)

expression in the content of a document conveying expected or conceivable material, physical or causal outcome

3.1.2

Company

owner or operator

3.1.3

may (permission)

expression in the content of a document conveying consent or liberty (or opportunity) to do something

Note 1 to entry: Permissions are expressed using the verbal forms specified in ISO/IEC Directives Part 2 clause 7.4 Table 5

3.1.4

shall (requirement)

expression in the content of a document conveying objectively verifiable criteria to be fulfilled and from which no deviation is permitted if compliance with the document is to be claimed

Note 1 to entry: Requirements are expressed using the verbal forms specified in ISO/IEC Directives, Part 2 clause 7.2 Table 3

3.1.5**should (recommendation)**

expression in the content of a document conveying a suggested possible choice or course of action deemed to be particularly suitable without necessarily mentioning or excluding others

Note 1 to entry: Recommendations are expressed using the verbal forms specified in ISO/IEC Directives, Part 2 clause 7.3 Table 4.

Note 2 to entry: In the negative form, a recommendation is the expression that a suggested possible choice or course of action is not preferred but it is not prohibited

3.1.6**supplier**

contract responsible supplier or fabricator

3.2 Abbreviations

API	American Petroleum Institute
ASME	American Society of Mechanical Engineers
CFD	computational fluid dynamics
DSB	Direktoratet for samfunnssikkerhet og beredskap (Norwegian Directorate for Civil Protection)
DN	nominal diameter
EN	European Norms
FAT	factory acceptance test
HTFS	heat transfer and fluid flow service
HTRI	Heat Transfer Research Inc.
IEC	International Electro technical Commission
IMO	International Maritime Organization
ISO	International Organization for Standardization
NFPA	National Fire Protection Association
NPSH	net positive suction head
NPSHA	net positive suction head available
NPSH3	net positive suction head required
NS	Norwegian Standard
PED	Pressure Equipment Directive
PM	preventive maintenance
PN	nominal pressure
RPM	revolutions per minute
TOD	true over design
WHRU	waste heat recovery unit

4 Selection of equipment in systems

Equipment application shall be done in accordance with project data sheets, project specifications and requirements in this standard.

The main design code or standard shall be stated on the relevant data sheets.

5 Technical requirements

5.1 General

5.1.1 Engineering basis

Machinery and static equipment taken into use on fixed offshore installations shall meet the requirements laid down in the Machinery Directive 2006/42/EC, ATEX Directives 94/9/EU and 2014/34/EU, and PED Directive 2014/68/EU.

All equipment shall be designed for ease of installation, operation and maintenance.

5.1.2 Requirements for piping, layout and system

All packages including a base plate shall have all interface flange connections at the edge of the base. If advantageous due to piping lay out, nozzle forces and pipe stress, etc., piping may be connected inside base edges, subject to Company approval. Piping terminations for each service shall have single inlet and outlet flange connections.

General piping design shall be in accordance with ASME B31.3, and comply with requirements in NORSOK L-001, L-002 and L-004.

Steel pipe flanges and flanged fittings design shall be in accordance with ASME B16.5 or ASME B16.47 series A for flange sizes over DN 600. Non-standard flanges and mechanical joints of proven design can also be used for special purposes.

Pipe threads shall be in accordance with ASME B1.20.1 for taper threads and ISO 228-1 for parallel threads.

Threaded connections in hydro carbon and other hazardous services shall be minimized in order to reduce external leakage. Threaded connections for these services shall be agreed with Company

Hatches, doors and man ways shall be provided as required for installation, operation, inspection, maintenance or repair. Provisions shall be made to secure them in open position. Reference is made to NORSOK S-002.

Equipment with walk-in enclosures shall have windows for visual control of conditions inside.

Liquid containing systems shall be completely drainable in all parts without dismantling, or use of manual methods.

Provisions shall be made to avoid air pockets during pressure testing.

Drains shall be provided on all casings.

Drain lines shall be brought out to the edge of the base plate, and individually valve installed.

Vent connections shall be provided with valves, except for atmospheric vents which are defined to be fixed open.

Valves shall be grouped and accessible within reach from the operating floor level.

Drain points shall have a second barrier against leakage or accidental emptying.

Systems and equipment shall be designed without pockets to avoid foreign matter accumulation.

Traps, strainers or filters shall be used to capture foreign matter detrimental to the equipment.

Systems or equipment which is dependent on liquid supply at emergency or other run-down situations shall be provided with emergency supply for the necessary period.

5.1.3 Mechanical design

Flow and rotation direction shall be permanently marked.

Equipment located on floating production facilities shall be designed for wave-induced fatigue.

On-site maintenance on mechanical equipment shall be possible without the use of heat with open flame.

Bolting materials shall be according to NORSOK M-001.