

Field instrumentation

This NORSOK standard is developed with broad petroleum industry participation by interested parties in the Norwegian petroleum industry and is owned by the Norwegian petroleum industry represented by The Norwegian Oil Industry Association (OLF) and The Federation of Norwegian Industry. Please note that whilst every effort has been made to ensure the accuracy of this NORSOK standard, neither OLF nor The Federation of Norwegian Industry or any of their members will assume liability for any use thereof. Standards Norway is responsible for the administration and publication of this NORSOK standard.

Standards Norway
Strandveien 18, P.O. Box 242
N-1326 Lysaker
NORWAY

Copyrights reserved

Telephone: + 47 67 83 86 00
Fax: + 47 67 83 86 01
Email: petroleum@standard.no
Website: www.standard.no/petroleum



Documents

Document Sharing Hub

Foreword	4
1 Scope	5
2 Normative and informative references	5
2.1 Normative references	5
2.2 Informative references	6
3 Terms, definitions, abbreviations and units	6
3.1 Terms and definitions	6
3.2 Abbreviations	6
3.3 Engineering units	7
4 Functional requirements	7
4.1 General	7
4.2 Instrument supplies	7
4.3 Signal types	8
4.4 Instrument design principles	8
4.5 Instrument installation design principles	9
4.6 Provision for future modifications	9
4.7 Degrees of protection by enclosures	10
4.8 Instrument materials	10
4.9 Air supply design	11
4.10 Instrument installation bulk materials	11
4.11 Temperature measurements	12
4.12 Flow measurements	13
4.13 Pressure measurement	13
4.14 Level measurement	14
4.15 Control valves	15
4.16 Solenoid valves	16
4.17 Pressure relief valves and bursting discs	16
4.18 Pilot operated relief valves	16
4.19 On/off valve actuators	16
4.20 Choke valves	17
4.21 HVAC actuators	17
4.22 Vibration field instruments	17
4.23 Fire and gas detectors	17
4.24 Diagnostics	19
5 Installation	19
5.1 General requirements	19
5.2 Equipment earthing and bonding (see NORSOK E-001, 9.1)	20
5.3 Cables and wiring (see IEC 61892-6, Clause 5, and NORSOK E-001, 9.2)	20
5.4 Marking and labelling (see NORSOK E-001, 9.12)	21
5.5 Bulk materials	22
5.6 Instruments	22
5.7 Tubing installation	23
5.8 Fire and gas	24
ANNEX A (informative) Typical installation drawings	25
ANNEX B (informative) Level measurement guidelines	26
ANNEX C (normative) Instrument data sheets	27

Foreword

The NORSOK standards are developed by the Norwegian petroleum industry to ensure adequate safety, value adding and cost effectiveness for petroleum industry developments and operations. Furthermore, NORSOK standards are, as far as possible, intended to replace oil company specifications and serve as references in the authorities' regulations.

The NORSOK standards are normally based on recognised international standards, adding the provisions deemed necessary to fill the broad needs of the Norwegian petroleum industry. Where relevant, NORSOK standards will be used to provide the Norwegian industry input to the international standardisation process. Subject to development and publication of international standards, the relevant NORSOK standard will be withdrawn.

The NORSOK standards are developed according to the consensus principle generally applicable for most standards work and according to established procedures defined in NORSOK A-001.

The NORSOK standards are prepared and published with support by The Norwegian Oil Industry Association (OLF), The Federation of Norwegian Industry, Norwegian Shipowners' Association and The Petroleum Safety Authority Norway.

NORSOK standards are administered and published by Standards Norway.

Annexes A and B are informative and Annex C is normative.

1 Scope

This NORSOK standard identifies the requirements to field instrumentation design.

2 Normative and informative references

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

2.1 Normative references

ANSI B16.10,	Face-to-face and end-to-end dimensions of valves
ANSI B16.36,	Steel orifice flanges
ANSI/ASME B1.20.1,	Pipe threads general purpose (inch)
ANSI/ASME,	Performance Test Codes 19.3 - 1974, chapter 1, section 8-19 Thermowells
ANSI B16.5,	Pipe Flanges and Flanged Fittings
API RP 520,	Sizing, Selection, and Installation of Pressure-Relieving Devices in Refineries, Part I and II
API RP 526,	Flanged steel safety relief valves
API RP 527,	Seat Tightness of Pressure Relief Valves
API RP 670,	Vibration, axial position and bearing temperature system
API RP 678,	Accelerometer-based Vibration Monitoring System
ASME VIII,	Boiler and pressure vessel code - Section VIII, Div. 1
DIN 3852-1,	Ports and stud ends with metric fine pitch thread, for use with compression couplings, valves and screw plugs
EN 50081-2,	Electromagnetic compatibility generic emission standard
EN 50082-2,	Electromagnetic compatibility generic immunity standard
EN 60751,	Resistance Temperature Detectors (RTD)
IEC 60079-14,	Electrical apparatus for explosive atmospheres – Part 14: Electrical installations in hazardous areas (others than mines)
IEC 60534-2-1,	Industrial-Process Control Valves – Part 2-1: Flow-Capacity Sizing Equations for Fluid Flow under Installed Conditions
IEC 61508,	Functional safety of electrical/electronic/programmable electronic safety-related Systems
IEC 61892-6,	Mobile and fixed offshore units - Electrical installations
ISA 75.01.01–2002,	Flow equations for sizing control valves
ISO 1000,	SI Units and recommendation for the use of their multiples and of certain other units
ISO 4126-2,	Safety devices for protection against excessive pressure – part 2: Bursting Disc Safety Devices
ISO 4406,	Hydraulic fluid power - Fluids - Method for coding the level of contamination by solid particles
ISO 5167 (all parts),	Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full -
NORSOK E-001,	Electrical systems
NORSOK I-002,	Safety and Automation System
NORSOK L-002,	Piping Design, Layout and Stress Analysis
NORSOK L-CR-003,	Piping Details
NORSOK L-004,	Piping fabrication
NORSOK L-005,	Compact flanged connections
NORSOK M-001,	Materials selection
NORSOK M-501,	Surface Preparation and Protective Coating
NORSOK S-001,	Technical safety
OLF 070,	"Guidelines for the Application of IEC 61508 in the petroleum activities on the continental shelf"
89/336/EEC,	Electromagnetic Compatibility Directive
PED,	Pressure Equipment Directive (97/23/EC)

2.2 Informative references

ATEX 94/9/EEC,	Explosive atmosphere
IEC 60529,	International Protection or Ingress Protection
EN 60584-1,	Thermocouples - Part 1: Reference tables
EN 60584-2,	Thermocouples - Part 2: Tolerances
BS 2915,	Specification for bursting discs and bursting disc devices

3 Terms, definitions, abbreviations and units

3.1 Terms and definitions

For the purposes of this NORSOK standard, the following terms, definitions and abbreviations apply.

3.1.1

can

verbal form used for statements of possibility and capability, whether material, physical or casual

3.1.2

instruments

devices used for indicating and/or control purposes

NOTE The term 'instruments' also includes actuated valves and safety valves.

3.1.3

may

verbal form used to indicate a course of action permissible within the limits of this NORSOK standard

3.1.4

shall

verbal form used to indicate requirements strictly to be followed in order to conform to this NORSOK standard and from which no deviation is permitted, unless accepted by all involved parties

3.1.5

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

3.2 Abbreviations

AISI	American Iron and Steel Institute
API	American Petroleum Institute
APS	abandon platform shutdown
ASME	The American Society of Mechanical Engineers
ATEX	Equipment intended for use in potentially explosive atmospheres
BS	British Standard
BSPP	British Standard Pipe Parallel
DIN	Deutsches Institut für Normung
EN	European Standard
ESD	emergency shut down
FF®	Foundation Fieldbus
GRP	glass fibre reinforced plastic
HART®	Highway Addressable Remote Transducer
HVAC	heating, ventilation and air conditioning
IE	instrument earthing
IEC	The International Electrotechnical Commission
IS	intrinsically safe
ISA	international organization of engineers
ISO	International Organization for Standardization
IP	ingress protections
IR	infra red
MCT	multi cable transit

N/A	not applicable
NAMUR	Normenarbeitsgemeinschaft für Mess- und Regelungstechnik in der Chemischen Industrie
NPT	National Pipe Thread
OD	outer diameter
OLF	The Norwegian Oil Industry Association
OPC	open connectivity (a series of standards specifications)
PED	Pressure Equipment Directive (97/23/EC)
Profibus DP, -PA®	Profibus Nutzerorganization
PSD	process shut down
RTD	resistance temperature detector
SAS	safety and automation system
SI	System International
SIL	safety integrity level
SMART	field instrument with distributed intelligence
SPL	sound pressure level
SS	stainless steel
UPS	uninterrupted power supply
V a.c	voltage alternating current
V d.c	voltage direct current

3.3 Engineering units

Pressure:	bar, mbar, barg, bara
Level:	mm, % for indication (for guidelines, see Annex A)
Volume flow:	m ³ /h (flowing condition), Sm ³ /h (standard condition, see ISO 1000)
Mass flow:	kg/h
Temperature:	°C

For other physical properties, SI units shall be utilised as per ISO 1000.

4 Functional requirements

4.1 General

This NORSOK standard shall be read in conjunction with NORSOK I-002.

4.2 Instrument supplies

Electrical supply to instrument panels in LERs: 230V a.c. 50 Hz (standard) or 24V d.c.

Electrical supply to field instruments: 24V d.c. (standard) or 230V a.c. 50 Hz.

Electrical supply to instrument field panels: 24V d.c. (standard) or 230V a.c. 50 Hz.

A minimum of two independent power supplies shall be used, one UPS and one main supply.
For critical systems/safety related systems power shall be supplied with fully redundant UPS.

24 V d.c. supply systems shall be floating and preferably adjustable within the range 24V d.c. to 28V d.c.
Earth fault and power fault monitoring shall be implemented in the 24V d.c. distribution system.

Pneumatic ring main supply: minimum 7 barg, maximum 10 barg.

Pneumatic instrument supply: 1,4 barg (standard) or as required.

Hydraulic ring main/instrument supply: minimum 180 barg, normal 200 barg, maximum 210 barg.

Hydraulic supply for wellhead/downhole depending on reservoir pressure.

An instrument air supply system with an online dew point analyzer connected to the SAS for alarm monitoring shall be installed.

4.3 Signal types

The following signal types shall be used:

- analogue input/output: 4 mA to 20 mA with HART® superimposed digital signal;
NOTE HART® shall be included if supported by existing technology for this type of instrument.
- digital input: potential free contact;
- digital output: 24V d.c.;
- signals between control systems and other panels shall be powered from SAS;
- position: proximity switches with NAMUR interface;
- pneumatic signals: 0,2 barg to 1,0 barg;
- fieldbus type and wireless communications may also be used, dependant on user approval.

4.4 Instrument design principles

Instrument performance/accuracy shall be sufficient to fulfil process/unit performance requirements and should be selected to reduce calibration intervals and maintenance to a minimum. Suppliers shall provide data for long-term stability and confidence level for performance specifications. Instruments shall have advanced diagnostics to enhance safety and reduce maintenance. Only industry standard communication protocols such as HART®, HART WIRELESS®, Foundation Fieldbus® or Profibus DP/PA® shall be used. Instruments using Foundation Fieldbus® or Profibus DP/PA® shall have documented interoperability, e.g. tick-marked.

Instrumented safety system shall satisfy the OLF 070 guideline and have a minimum SIL requirement according IEC 61508. A safety analysis Report shall be part of any delivery. For off-the-shelf instruments where a failure mode effect and diagnostic analysis report or a certificate is available this can be regarded as a safety analysis report, provided it presents the data required in the OLF 070 in an easily accessible manner.

Variation of instrument types and ranges shall be kept to a minimum, e.g. thermowell lengths/transmitter ranges.

Analogue instruments shall be used instead of field switch functions, e.g. pressure transmitters versus pressure switches.

Galvanic isolation barriers shall be used for input/output signals. These barriers shall have full HART® signal transmission capability.

Field instruments and controllers of pneumatic type shall be avoided.

Where local indicators are required, local indicators and transmitters shall be combined. Separate local indicators may only be installed if necessary for local operation if process control system is not in function.

Any arrangement of instruments shall allow for the removal of a sensor/detector head while maintaining the integrity of the other sensors, e.g. in addressable systems.

Instruments shall meet requirements according to 89/336/EEC, and EN 50081-2 and EN 50082-2 regarding electromagnetic compatibility.

Flange connection for inline instruments shall follow piping class and specification, see ANSI B16.5 or compact flanges according to NORSOK L-005.

All in-line flow elements (when part of the process line) shall be flanged for removal from the process line.

Pressure vessel design (e.g. accumulators for on/off valves) shall follow NORSOK L-002 and meet the requirements of the PED.

The most frequently used measuring principles are specified in separate sections of this NORSOK standard. Other types may be used on special applications.

For field instruments not specifically dealt with in this NORSOK standard, the design shall be based on recognised international standards.

4.5 Instrument installation design principles

Instrument lines that can be clogged due to high viscosity fluids or hydrates or other factors, shall either have the instrument close-coupled to the process pipeline/equipment or protected with a chemical seal. If chemical seals are installed, a flushing ring arrangement should also be provided for flushing of diaphragm surface. Double block/bleed (3-way modular) valves to enable in-situ calibration shall be fitted.

All equipment which require maintenance or calibration etc. shall have easy access, e.g. permanent platforms or fixed ladders.

Instrumentation used for hydrocarbon services shall be constructed in such a way that any fault in the primary process barrier will not leak into the main compartment or junction box. If a leakage occurs, it shall not be possible to build up any pressure inside the instruments.

Pressure instruments shall have individual process isolation valves. Combined solutions may be used providing they do not cause an operational disadvantage or safety reduction during servicing of instruments etc.

Each pressure instrument with process connection shall be fitted with instrument block/bleed manifold (2/5 - way valve).

Instruments for ESD/PSD shall in addition have locking devices for latching of the valves in open position.

Full functional independence between control and safety devices shall be assured, including vessel/pipeline connections, e.g. common pressure tap for control and safety devices shall not be used.

Use of combined manifolds for piping and instruments valves shall be evaluated. Combined manifolds should be used when instruments are direct mounted on or in the immediate vicinity of the pipe/vessel.

Package suppliers shall terminate hydraulic and pneumatic tubing at skid edge with bulkhead male connectors or unions.

Package suppliers shall terminate instrumentation cables in junction boxes at skid edge or at agreed termination point.

Ex-certified equipment should be selected in accordance with the following guidelines and be certified according to ATEX 94/9/EEC:

- Ex i and Ex e should be used;
- if Ex d is used, it shall be provided with an Ex e indirect entry. Compression type Ex d gland may be accepted if the equipments ATEX certificate cover gland and installed cable type, actual gas group and Ex d compartment volume (normally under 2 litre.). References to figure 1 in IEC 60079-14. Ex d compression glands shall be of the type where the braid is terminated in the gland and compression takes place on inner cable sheath;
- Ex q and Ex p should be avoided. Use of these will be upon approval from user and if used should be via an Ex e junction box;
- Ex e, Ex s, Ex m or Ex i solenoid valves shall be used. Ex d may be used upon approval from user;
- equipment, which remains energized after an APS/ESD situation, shall follow the requirements specified in NORSOK S-001, 9.4.

If safety and functional requirements are fulfilled, the following shall apply:

- field instrument process connection: 1/2 in NPT, see ANSI/ASME B1.20.1;
- field instrument pneumatic connection: 1/4 in NPT;
- field instrument hydraulic connection: 1/2 in NPT, or 1/2 in BSPP to DIN 3852-1;
- field instrument cable entry: ISO threads - size depending on cable size.

4.6 Provision for future modifications

This subclause defines the spare capacity that shall be provided at the time of plant start-up.

The installation should be prepared as follows:

- interface cabinets, junction boxes, multicore cabling etc. shall be sized to meet a 10 % increase;