IEC 62887

Edition 1.0 2018-05

INTERNATIONAL STANDARD

NORME INTERNATIONALE

colour inside

Nuclear power plants – Instrumentation systems important to safety – Pressure transmitters: Characteristics and test methods

Centrales nucléaires de puissance – Systèmes d'instrumentation importants pour la sûreté – Transmetteurs de pression: Caractéristiques et méthodes d'essai

IEC 62887:2018-05(en-fr)

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INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

COMMISSION
ELECTROTECHNIQUE
INTERNATIONALE

ICS 27.120.20

ISBN 978-2-8322-5723-4

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NUCLEAR POWER PLANTS – INSTRUMENTATION SYSTEMS IMPORTANT TO SAFETY – PRESSURE TRANSMITTERS: CHARACTERISTICS AND TEST METHODS

FOREWORD

International Standard IEC 62887 has been prepared by subcommittee 45A: Instrumentation, control and electrical power systems of nuclear facilities, of IEC technical committee 45: Nuclear instrumentation.

The text of this International Standard is based on the following documents:

FDIS	Report on voting
45A/1193/FDIS	45A/1205/RVD

Full information on the voting for the approval of this International Standard can be found in the report on voting indicated in the above table.

This document has been drafted in accordance with the ISO/IEC Directives, Part 2.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under "http://webstore.iec.ch" in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

IMPORTANT – The 'colour inside' logo on the cover page of this publication indicates that it contains colours which are considered to be useful for the correct understanding of its contents. Users should therefore print this document using a colour printer.

INTRODUCTION

a) Technical background, main issues and organisation of the Standard

This International standard focuses on pressure transmitters and tests methods.

It is intended that this Standard will be used by operators of NPPs (utilities), systems evaluators and by licensors.

b) Situation of the current Standard in the structure of the IEC SC 45A standard series

IEC 62887 is a third level IEC SC 45A document covering pressure transmitters.

IEC 62887 is to be read in conjunction with IEC 61513 which establishes requirements for instrumentation systems important to safety.

For more details on the structure of the IEC SC 45A standard series, see item d) of this introduction.

c) Recommendations and limitations regarding the application of the Standard

This Standard provides more particularly recommendations for the following aspects.

- selection,
- characteristics,
- manufacture and control,
- qualification,
- obsolescence.

To ensure that the Standard will continue to be relevant in future years, the emphasis has been placed on issues of principle, rather than specific technologies.

d) Description of the structure of the IEC SC 45A standard series and relationships with other IEC documents and other bodies documents (IAEA, ISO)

The top-level documents of the IEC SC 45A standard series are IEC 61513 and IEC 63046. IEC 61513 provides general requirements for I&C systems and equipment that are used to perform functions important to safety in NPPs. IEC 63046 provides general requirements for electrical power systems of NPPs; it covers power supply systems including the supply systems of the I&C systems. IEC 61513 and IEC 63046 are to be considered in conjunction and at the same level. IEC 61513 and IEC 63046 structure the IEC SC 45A standard series and shape a complete framework establishing general requirements for instrumentation, control and electrical systems for nuclear power plants.

IEC 61513 and IEC 63046 refer directly to other IEC SC 45A standards for general topics related to categorization of functions and classification of systems, qualification, separation, defense against common cause failure, control room design, electromagnetic compatibility, cybersecurity, software and hardware aspects for programmable digital systems, coordination of safety and security requirements and management of ageing. The standards referenced directly at this second level should be considered together with IEC 61513 and IEC 63046 as a consistent document set.

At a third level, IEC SC 45A standards not directly referenced by IEC 61513 or by IEC 63046 are standards related to specific equipment, technical methods, or specific activities. Usually these documents, which make reference to second-level documents for general topics, can be used on their own.

A fourth level extending the IEC SC 45A standard series, corresponds to the Technical Reports which are not normative.

The IEC SC 45A standards series consistently implements and details the safety and security principles and basic aspects provided in the relevant IAEA safety standards and in the relevant documents of the IAEA nuclear security series (NSS). In particular this includes the IAEA requirements SSR-2/1, establishing safety requirements related to the design of nuclear power plants (NPPs), the IAEA safety guide SSG-30 dealing with the safety classification of structures, systems and components in NPPs, the IAEA safety guide SSG-39 dealing with the design of instrumentation and control systems for NPPs, the IAEA safety guide SSG-34 dealing with the design of electrical power systems for NPPs and the implementation guide NSS17 for computer security at nuclear facilities. The safety and security terminology and definitions used by SC 45A standards are consistent with those used by the IAEA.

IEC 61513 and IEC 63046 have adopted a presentation format similar to the basic safety publication IEC 61508 with an overall life-cycle framework and a system life-cycle framework. Regarding nuclear safety, IEC 61513 and IEC 63046 provide the interpretation of the general requirements of IEC 61508-1, IEC 61508-2 and IEC 61508-4, for the nuclear application sector. In this framework IEC 60880, IEC 62138 and IEC 62566 correspond to IEC 61508-3 for the nuclear application sector. IEC 61513 and IEC 63046 refer to ISO as well as to IAEA GS-R-3 and IAEA GS-G-3.1 and IAEA GS-G-3.5 for topics related to quality assurance (QA). At level 2, regarding nuclear security, IEC 62645 is the entry document for the IEC SC 45A security standards. It builds upon the valid high level principles and main concepts of the generic security standards, in particular ISO/IEC 27001 and ISO/IEC 27002; it adapts them and completes them to fit the nuclear context and coordinates with the IEC 62443 series. At level 2, IEC 60964 is the entry document for the IEC SC 45A control rooms standards and IEC 62342 is the entry document for the IEC SC 45A ageing management standards.

NOTE 1 It is assumed that for the design of I&C systems in NPPs that implement conventional safety functions (e.g. to address worker safety, asset protection, chemical hazards, process energy hazards) international or national standards would be applied.

NOTE 2 IEC SC 45A domain was extended in 2013 to cover electrical systems. In 2014 and 2015 discussions were held in IEC SC 45A to decide how and where general requirement for the design of electrical systems were to be considered. IEC SC 45A experts recommended that an independent standard be developed at the same level as IEC 61513 to establish general requirements for electrical systems. Project IEC 63046 is now launched to cover this objective. When IEC 63046 is published this NOTE 2 of the introduction of IEC SC 45A standards will be suppressed.

NUCLEAR POWER PLANTS – INSTRUMENTATION SYSTEMS IMPORTANT TO SAFETY – PRESSURE TRANSMITTERS: CHARACTERISTICS AND TEST METHODS

1 Scope

This document is applicable to general aspects of design, manufacturing and test methods for pressure transmitters used in instrumentation systems important to safety in all nuclear power plants (PWR, BWR, FBR, etc.). The conditions imposed by reactor use are often different from those which occur in non-nuclear applications. Exposure to radiations (mainly neutron, gamma, even beta) is liable to cause alterations in the measurements. Mechanical and electrical properties of transmitters can be affected by nuclear transformations, heating and structural changes. Particular attention is paid to the adoption of standards for the choice of materials and installation. Furthermore, design consideration is given to the effects of high environmental pressure, high temperature, chemical spray, temperature gradients and temperature cycling as well as to the way in which the temperature and pressure measuring system could influence the safety or economic performance of the reactor.

The consequences of nuclear conditions for pressure transmitters lead to onerous requirements regarding qualification.

This document deals with specific requirements for nuclear applications of pressure transmitters including design, materials, manufacturing, testing, calibration and inspection.

For applications in non-nuclear areas of a NPP, IEC standards used for industrial products apply.

This document deals only with transmitters, the boundaries are:

– Sensing elements.
– Electronics converters.
– Electrical connection.
– Process connection.
– Sealed systems.

Instrumentation systems using pressure transmitters as components (such as flowmeter, level measurement) or other components connecting to transmitters (such as sensing lines, valves) are not in the scope of this document.

Remote seals are considered as components of transmitters and are treated.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 60770 (all parts), *Transmitters for use in industrial-process control systems*

IEC/IEEE 60780-323, *Nuclear facilities – Electrical equipment important to safety – Qualification*

IEC 61298 (all parts), *Process measurement and control devices – General methods and procedures for evaluating performance*

IEC 61298-1, *Process measurement and control devices – General methods and procedures for evaluating performance – Part 1: General considerations*

IEC 62402:2007,*Obsolescence management – Application guide*

IEC 62566, *Nuclear power plants – Instrumentation and control important to safety – Development of HDL-programmed integrated circuits for systems performing category A functions*

IEC 62566-2, *Nuclear power plants – Instrumentation and control important to safety – Development of HDL-programmed integrated circuits for systems performing category B or C functions*

IEC 62765-1, *Nuclear powers plants – Instrumentation and control important to safety – Management of ageing of sensors and transmitters – Part 1: Pressure transmitters*

IEC Guide 115, *Application of uncertainty of measurement to conformity assessment activities in the electrotechnical sector*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- IEC Electropedia: available at http://www.electropedia.org/
- ISO Online browsing platform: available at http://www.iso.org/obp

3.1
absolute pressure sensor
sensor which makes the measurement with vacuum as reference

EXAMPLE: Examples of associated units: kPa abs, MPa abs, bar abs.

3.2
accident conditions
deviations from normal operation that are less frequent and more severe than anticipated operational occurrences

EXAMPLE: Examples of such deviations include a major fuel failure or a loss of coolant accident (LOCA).

Note 1 to entry: Accident conditions comprise design basis accidents and design extension conditions.

[SOURCE: IAEA safety glossary, 2016 edition]

3.3
accident management
the taking of a set of actions during the evolution of a beyond design basis accident:

a) to prevent the escalation of the event into a severe accident;

b) to mitigate the consequences of a severe accident;

c) to achieve a long term safe stable state.

Note 1 to entry: The second aspect of accident management (to mitigate the consequences of a severe accident) is also termed severe accident management.

[SOURCE: IAEA safety glossary, 2016 edition]

3.4
accuracy <of a measuring instrument>
quality which characterizes the ability of a measuring instrument to provide an indicated value close to a true value of the measurand

Note 1 to entry: This term is used in the "true value" approach.

Note 2 to entry: Uncertainty is all the better when the indicated value is closer to the corresponding true value.

[SOURCE: IEC 60050-311:2001, 311-06-08]

3.5
anticipated operational occurrence
deviation of an operational process from normal operation that is expected to occur at least once during the operating lifetime of a facility but which, in view of appropriate design provisions, does not cause any significant damage to items important to safety or lead to accident conditions

EXAMPLE: Examples of anticipated operational occurrences are loss of normal electrical power and faults such as a turbine trip, malfunction of individual items of a normally running plant, failure to function of individual items of control equipment, and loss of power to the main coolant pump.

[SOURCE: IAEA safety glossary, 2016 edition]

3.6
beyond design basis accident
postulated accident with accident conditions more severe than those of a design basis accident

[SOURCE: IAEA safety glossary, 2016 edition]

3.7
calibration
set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by measurement standards

Note 1 to entry: A calibration may be expressed by a statement, calibration function, calibration diagram, calibration curve, or calibration table. In some cases, it may consist of an additive or multiplicative correction of the indication with associated measurement uncertainty.

[SOURCE: IAEA Safety Glossary, edition 2016]

3.8
capillary
thin pipe filled with a fluid which transfers the pressure information from the separator to the sensor

3.9
component
one of the parts that make up a system. A component may be a hardware component (e.g. wires, transistors, integrated circuits, motors, relays, solenoids, pipes, fittings, pumps, tanks and valves) or a software component (e.g. modules, routines, programmes, software functions). A component may be made up of other components

[SOURCE: IAEA Safety Glossary, edition 2016]

3.10
converter
electronic part which processes the electrical quantities of the sensor to provide a conditioned signal conforming to the required format

3.11
design basis accident
postulated accident leading to accident conditions for which a facility is designed in accordance with established design criteria and conservative methodology, and for which releases of radioactive material are kept within acceptable limits

[SOURCE: IAEA safety glossary, 2016 edition]

3.12
diaphragm seal
device equipped with diaphragm seal to isolate the process circuit from the measurement channel

Note 1 to entry: Equivalent to “separator”.

3.13
differential pressure sensor
sensor which gives a signal proportional to the pressure difference between HP/LP chambers

EXAMPLE: Examples of associated units: kPa, MPa, bar.

3.14
drift
change in the indication of a measuring instrument, generally slow, continuous, not necessarily in the same direction and not related to a change in the measurand

[SOURCE: IEC 60050-311:2001, 311-06-13]

3.15
integrated transmitter
transmitter where the electronic converter is mounted as an integral part of an assembly containing the sensing element

Note 1 to entry: Integrated transmitter can be named monobloc transmitter.

3.16
normal operation
operation within specified operational limits and conditions

[SOURCE: IAEA safety glossary, 2016 edition]

3.17
obsolescence
transition from availability from the original manufacturer to unavailability

[SOURCE: IEC 62402:2007, 3.1.16.1]

3.18
obsolescence management
coordinated activities to direct and control an organization with regard to obsolescence

[SOURCE: IEC 62402:2007, 3.1.17]

3.19
operational states
states defined under normal operation and anticipated operational occurrences

Note 1 to entry: Some States and organizations use the term operating conditions (for contrast with accident conditions) for this concept.

[SOURCE: IAEA safety glossary, 2016 edition]

3.20
plant states

Operational states		Accident conditions		
Normal operation	Anticipated operational occurrences	Design basis accidents	Design extension conditions	
			Without significant fuel degradation	With core melting

[SOURCE: IAEA safety glossary, 2016 edition]

3.21
receiver

electronic device connected to the output of the converter which treats the transmitter signal

3.22
relative pressure sensor

sensor which makes the measurement with ambient pressure as reference

EXAMPLE: Examples of associated units: kPa g, MPa g, bar g.

Note 1 to entry: Equivalent to “gauge pressure sensor”.

3.23
remote seal
part composed of separator, capillary, sensor and filled with fluid

Note 1 to entry: The term sealed system can be used to designate remote seal.

3.24
response time <of a component>
period of time necessary for a component to achieve a specified output state from the time that it receives a signal requiring it to assume that state

Note 1 to entry: IEC 61298-2 defines the methodology to proceed to the measurement.

[SOURCE: IAEA safety glossary, 2016 edition]

3.25
sensor
measuring element, part of a measuring instrument, or measuring chain, which is directly affected by the measurand and which generates a signal related to the value of the measurand

[SOURCE: IEC 60050-311:2001, 311-05-01]

3.26
separate transmitter
transmitter mounted at a location removed (locally or remotely) from an assembly containing the sensing element but connected to it by signal line

Note 1 to entry: A head-mounted transmitter is a separate transmitter mounted in a connection head.

Note 2 to entry: Separate transmitters can be named bibloc transmitters.

[SOURCE: IEC 61987-11:2016, 3.1.9]

3.27
severe accident
accident conditions more severe than a design basis accident and involving significant core degradation

[SOURCE: IAEA safety glossary, 2016 edition]

3.28
span
algebraic difference between the values of the upper and lower limits of the measuring range corresponding respectively to 0 % and 100 % signals

Note 1 to entry: The span is contained in URL.

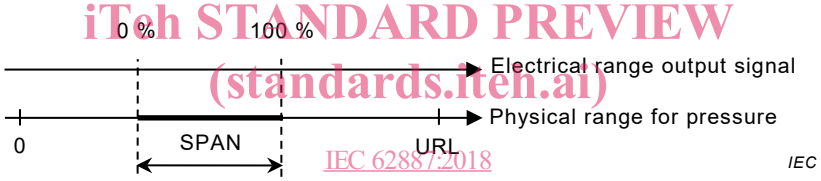

Figure 1 – Span and URL

3.29
system
set of components which interact according to a design, where an element of a system can be another system, called a subsystem.

[SOURCE: IEC 61513:2011, 3.56]

3.30
time constant
in the case of a first order system, the time required for the output signal of a system to reach 63,2 % of its final variation after a step change of its input signal. If the system is not a first order system, the term "time constant" is not appropriate. For a system of a higher order, the term "response time" should be used

[SOURCE: IEC 62397:2007, 3.9]

3.31
transducer
device which accepts information in the form of a physical quantity and converts it into information in the form of the same or another physical quantity according to a definite law

3.32
transmitter
device measuring a physical quantity (for example: pressure) and converts it into a conditioned and calibrated electric signal