

This is a preview of "PD IEC/TR 62918:2014". [Click here to purchase the full version from the ANSI store.](#)

PD IEC/TR 62918:2014



BSI Standards Publication

**Nuclear power plants —
Instrumentation and control
important to safety — Use
and selection of wireless
devices to be integrated in
systems important to safety**

bsi.

...making excellence a habit.™

This is a preview of "PD IEC/TR 62918:2014". [Click here to purchase the full version from the ANSI store.](#)

This Published Document is the UK implementation of IEC/TR 62918:2014.

The UK participation in its preparation was entrusted to Technical Committee NCE/8, Reactor instrumentation.

A list of organizations represented on this committee can be obtained on request to its secretary.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

© The British Standards Institution 2014.
Published by BSI Standards Limited 2014

ISBN 978 0 580 85816 1
ICS 27.120.20

Compliance with a British Standard cannot confer immunity from legal obligations.

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 31 August 2014.

Amendments/corrigenda issued since publication

Date	Text affected
-------------	----------------------

This is a preview of "PD IEC/TR 62918:2014". [Click here to purchase the full version from the ANSI store.](#)



Edition 1.0 2014-07

TECHNICAL REPORT



**Nuclear power plants – Instrumentation and control important to safety –
Use and selection of wireless devices to be integrated in systems
important to safety**

INTERNATIONAL
ELECTROTECHNICAL
COMMISSION

PRICE CODE **XB**

ICS 27.120.20

ISBN 978-2-8322-1750-4

Warning! Make sure that you obtained this publication from an authorized distributor.

This is a preview of "PD IEC/TR 62918:2014". [Click here to purchase the full version from the ANSI store.](#)

CONTENTS

FOREWORD	5
INTRODUCTION	7
1 Scope	9
2 Normative references	9
3 Terms and definitions	9
4 Motivation	11
5 Generic applications	13
6 Technology	16
6.1 Wireless basics	16
6.2 Industrial wireless sensor networks	19
6.3 Radio frequency	20
6.3.1 Applications	20
6.3.2 802.11 (Wi-Fi), 802.15.1 (Bluetooth), 802.15.4 (sensors)	23
6.4 Satellite leased channels and VSAT	25
6.5 Magnetic field communications	26
6.6 Visual light communication (VLC)	27
6.7 Acoustic communication	27
6.8 Asset tracking utilizing IEEE 802.11 – Focus on received signal strength	28
6.9 Asset tracking (RFID/RTLS): ISO 24730	29
7 Current wireless technology implementations	30
7.1 General	30
7.2 Comanche Peak nuclear generating station	30
7.3 Arkansas Nuclear One (ANO) nuclear power plant	31
7.4 Diablo Canyon nuclear power plant	32
7.5 Farley nuclear power plant	33
7.6 San Onofre nuclear generating station	33
7.7 South Texas project electric generating station	34
7.8 High Flux Isotope Reactor (HFIR), Oak Ridge, TN	34
8 Considerations	36
8.1 General	36
8.2 Concerns regarding wireless technology	36
8.3 Wireless deployment challenges	37
8.4 Coexistence of 802.11 and 802.15.4	38
8.5 Signal propagation	40
8.6 Lessons learned from wireless implementations	41
8.6.1 General	41
8.6.2 Comanche Peak implementation	41
9 Concerns	42
9.1 Common reliability and security concerns for wired media and wireless media	42
9.2 Reliability and security concerns that are more of an issue for wired systems	42
9.3 Reliability and security concerns that are more of an issue for wireless systems	42
10 Standards	43
10.1 Nuclear standards	43

This is a preview of "PD IEC/TR 62918:2014". [Click here to purchase the full version from the ANSI store.](#)

10.1.1	General	43
10.1.2	IEEE Std. 603-1998	43
10.1.3	IEEE Std. 7-4.3.2-2003	44
10.1.4	IEC 61500	44
10.2	Other safety-related standards and guidelines	45
10.2.1	IEC 61784-3	45
10.2.2	VTT research notes 2265.....	46
10.2.3	European Workshop on Industrial Computer Systems – Technical Committee 7 (EWICS TC7)	47
11	Conclusions.....	47
11.1	Issues for wireless application to NPP	47
11.2	Recommendations	48
Annex A	(informative) Use of 5 GHz in the world.....	50
Annex B	(informative) Synopses of wireless technologies	51
B.1	802.11	51
B.2	ISO 14443 Near Field Communications (NFC)	56
B.3	Real details of mesh networking	59
B.4	Not all mesh networks are created equal – Latency and indeterminism in mesh networks.....	62
B.5	ISA100.11a – “Mesh – When You Need It – Networking”	63
B.6	Security by non-routing edge nodes	66
B.7	Device and network provisioning methods.....	67
	Bibliography.....	69
	Figure 1 – Cost comparison – Wired versus wireless for an extensive building automation system.....	12
	Figure 2 – Wireless use in nuclear power plants	12
	Figure 3 – Possible application areas for wireless instrumentation in a nuclear power plant	13
	Figure 4 – Bandwidth requirements for a variety of applications and the associated wireless technology that can support such requirements.....	14
	Figure 5 – Structured fabric design of layered wireless for an industrial facility	15
	Figure 6 – Inexpensive wireless sensors in a fossil-fuel plant.....	16
	Figure 7 – Functional hierarchy.....	18
	Figure 8 – Simplified diagram of a generic wireless sensor design	19
	Figure 9 – Standard compliant network	20
	Figure 10 – 802.15.1 (Bluetooth) frequency channels in the 2 450 MHz range	23
	Figure 11 – 802.15.4 frequency channels in the 2 450 MHz range	24
	Figure 12 – Overlapping channel assignments for 802.11 operation in the 2 400 MHz range.....	24
	Figure 13 – 802.11n dual stream occupies 44 MHz of bandwidth. Dual stream 802.11n in the 2,4 GHz band.....	25
	Figure 14 – VSAT mini-hub network configuration.....	26
	Figure 15 – Spatial resolution is provided in multiple axes only if the tag (target in this Figure) is in communications with multiple APs.....	28
	Figure 16 – ISO 24730-2 architecture	29
	Figure 17 – Wireless vibration system at ANO	32
	Figure 18 – ANO wireless tank level system	33

This is a preview of "PD IEC/TR 62918:2014". [Click here to purchase the full version from the ANSI store.](#)

Figure 19 – Installation of accelerometers on ORNL HFIR cold source expansion engines (9-2010).....	35
Figure 20 – Cold source expansion engine monitoring system software	35
Figure 21 – Installation of permanent wireless monitoring system at ORNL HFIR cooling tower (8-2011)	36
Figure 22 – System commissioned in August 2011	36
Figure 23 – Identification of containment in a nuclear facility	38
Figure 24 – Non-overlapping 802.11b/g channels and 802.15.4 channels	39
Figure 25 – Spectral analysis of Wi-Fi traffic for the case where a) minimal wi-fi channel “usage” and b) streaming video transfer across Wi-Fi channel 7 are analyzed	39
Figure 26 – Multipath is exemplified in this indoor environment as the signal from Source (S) to Origin (O) may take many paths	41
Figure B.1 – The Open Systems Interconnection (OSI) model defines the end-to-end communications means and needs for a wireless field transmitter to securely communicate with a distributed control system (DCS)	57
Figure B.2 – Operating frequencies for an IEEE 802.15.4 radio are 868 MHz, 902-926 MHz and 2 405-2 485 MHz. The worldwide license-free band at 2400 MHz is shown	58
Figure B.3 – Networking topologies take many forms with associated levels of complexity required for robust fault-tolerant data transport.....	58
Figure B.4 – Typical mesh network diagram.....	59
Figure B.5 – Requirement for mesh-networking communication of Figure B.4’s topology.....	60
Figure B.6 – RF footprint map for a mesh network gateway and four nodes	61
Figure B.7 – The connectivity diagram for Figure B.6’s RF footprint coverage map	61
Figure B.8 – Representation of the latency and indeterminism that it takes for a message to be transported through a mesh network that relies on time synchronization	63
Figure B.9 – The technical specifications associated with ISA100.11a end at the gateway. The area shaded falls within the Backhaul Work Group, ISA100.15.....	64
Figure B.10 – ISA100.11a utilizes the best topology for the application, in this case, a star	64
Figure B.11 – ISA100.11a allows for the deployment of multiple “hub and spoke” network elements with high speed interconnection to a gateway	65
Figure B.12 – The ISA100.11a network deployed at Arkema was a logical mix of wireless field transmitters and an ISA100.15 backhaul network.....	65
Figure B.13 – Networks deployed at neighbouring facilities will not “cross-talk” if non-routing nodes are deployed along the periphery of each facility	66
Figure B.14 – State transition diagram showing various paths to joining a secured network.....	68
Table 1 – List of “industrial” radio technology standards and their candidate applications	21
Table 2 – Cellular telephony frequencies in the US	22
Table 3 – GSM frequency bands, channel numbers assigned by the ITU	23
Table 4 – Specific uses of wireless technologies in the nuclear industry	30
Table A.1 – Use of 5 GHz in America, Asia/Pacific, and Europe	50

This is a preview of "PD IEC/TR 62918:2014". [Click here to purchase the full version from the ANSI store.](#)

INTERNATIONAL ELECTROTECHNICAL COMMISSION

NUCLEAR POWER PLANTS – INSTRUMENTATION AND CONTROL IMPORTANT TO SAFETY – USE AND SELECTION OF WIRELESS DEVICES TO BE INTEGRATED IN SYSTEMS IMPORTANT TO SAFETY

FOREWORD

- 1) The International Electrotechnical Commission (IEC) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, IEC publishes International Standards, Technical Specifications, Technical Reports, Publicly Available Specifications (PAS) and Guides (hereafter referred to as "IEC Publication(s)"). Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
- 2) The formal decisions or agreements of IEC on technical matters express, as nearly as possible, an international consensus of opinion on the relevant subjects since each technical committee has representation from all interested IEC National Committees.
- 3) IEC Publications have the form of recommendations for international use and are accepted by IEC National Committees in that sense. While all reasonable efforts are made to ensure that the technical content of IEC Publications is accurate, IEC cannot be held responsible for the way in which they are used or for any misinterpretation by any end user.
- 4) In order to promote international uniformity, IEC National Committees undertake to apply IEC Publications transparently to the maximum extent possible in their national and regional publications. Any divergence between any IEC Publication and the corresponding national or regional publication shall be clearly indicated in the latter.
- 5) IEC itself does not provide any attestation of conformity. Independent certification bodies provide conformity assessment services and, in some areas, access to IEC marks of conformity. IEC is not responsible for any services carried out by independent certification bodies.
- 6) All users should ensure that they have the latest edition of this publication.
- 7) No liability shall attach to IEC or its directors, employees, servants or agents including individual experts and members of its technical committees and IEC National Committees for any personal injury, property damage or other damage of any nature whatsoever, whether direct or indirect, or for costs (including legal fees) and expenses arising out of the publication, use of, or reliance upon, this IEC Publication or any other IEC Publications.
- 8) Attention is drawn to the Normative references cited in this publication. Use of the referenced publications is indispensable for the correct application of this publication.
- 9) Attention is drawn to the possibility that some of the elements of this IEC Publication may be the subject of patent rights. IEC shall not be held responsible for identifying any or all such patent rights.

The main task of IEC technical committees is to prepare International Standards. However, a technical committee may propose the publication of a technical report when it has collected data of a different kind from that which is normally published as an International Standard, for example "state of the art".

IEC TR 62918, which is a technical report, has been prepared by subcommittee 45A: Instrumentation, control and electrical systems of nuclear facilities, of IEC technical committee 45: Nuclear instrumentation.

This is a preview of "PD IEC/TR 62918:2014". [Click here to purchase the full version from the ANSI store.](#)

The text of this technical report is based on the following documents:

Enquiry draft	Report on voting
45A/947/DTR	45A/963/RVC

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

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

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

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

A bilingual version of this publication may be issued at a later date.

IMPORTANT – Le logo "*colour inside*" qui se trouve sur la page de couverture de cette publication indique qu'elle contient des couleurs qui sont considérées comme utiles à une bonne compréhension de son contenu. Les utilisateurs devraient, par conséquent, imprimer cette publication en utilisant une imprimante couleur.

INTRODUCTION

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

The ad hoc meeting of the IEC Technical Working Group on Nuclear Power Plant Control and Instrumentation, held in Yokohama in May 2009, resulted in the recommendation to develop a technical report addressing the applicability of incorporating wireless technology throughout nuclear power plant systems, regardless of the categorizations such as non-safety, important to availability and important to safety.

This technical report addresses this recommendation and one of its main objectives is to pave the way for the development of a standard on the topic. The technical report addresses concerns regarding the application, safety and security of integrating wireless technologies into the systems of nuclear power plants. It reviews the motivation for use of wireless applications in nuclear power plants, wireless technology considerations, and the feasibility of incorporating wireless technology in nuclear power plants.

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

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

IEC 62918 as a technical report is a fourth level IEC SC 45A document.

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 this Technical Report

It is important to note that a technical report is entirely informative in nature. It gathers data collected from different origins and it establishes no requirements.

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 document of the IEC SC 45A standard series is IEC 61513. It provides general requirements for I&C systems and equipment that are used to perform functions important to safety in NPPs. IEC 61513 structures the IEC SC 45A standard series.

IEC 61513 refers directly to other IEC SC 45A standards for general topics related to categorization of functions and classification of systems, qualification, separation of systems, defence against common cause failure, software aspects of computer-based systems, hardware aspects of computer-based systems, and control room design. The standards referenced directly at this second level should be considered together with IEC 61513 as a consistent document set.

At a third level, IEC SC 45A standards not directly referenced by IEC 61513 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.

IEC 61513 has adopted a presentation format similar to the basic safety publication IEC 61508 with an overall safety life-cycle framework and a system life-cycle framework. Regarding nuclear safety, it provides the interpretation of the general requirements of IEC 61508-1, IEC 61508-2 and IEC 61508-4, for the nuclear application sector, regarding nuclear safety. In this framework IEC 60880 and IEC 62138 correspond to IEC 61508-3 for the nuclear application sector. IEC 61513 refers 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).

The IEC SC 45A standards series consistently implements and details the principles and basic safety aspects provided in the IAEA code on the safety of NPPs and in the IAEA safety series, in particular the Requirements SSR-2/1, establishing safety requirements related to the design of Nuclear Power Plants, and the Safety Guide NS-G-1.3 dealing with instrumentation and control systems important to safety in Nuclear Power Plants. The

This is a preview of "PD IEC/TR 62918:2014". [Click here to purchase the full version from the ANSI store.](#)

terminology and definitions used by SC 45A standards are consistent with those used by the IAEA.

NOTE 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, that are based on the requirements of a standard such as IEC 61508.

This is a preview of "PD IEC/TR 62918:2014". [Click here to purchase the full version from the ANSI store.](#)

NUCLEAR POWER PLANTS – INSTRUMENTATION AND CONTROL IMPORTANT TO SAFETY – USE AND SELECTION OF WIRELESS DEVICES TO BE INTEGRATED IN SYSTEMS IMPORTANT TO SAFETY

1 Scope

This Technical Report describes the state of wireless technology for industrial applications in fossil and chemical plants and discusses the specific issues to be addressed in order to apply wireless technologies to nuclear power plants.

The review of the technology behind wireless communication and the status of existing implementations are described in Clauses 7 and 8, respectively. Issues associated with wireless implementations in nuclear facilities are discussed in Clause 10, and final conclusions are presented in Clause 11 of this Technical Report.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 61508 (all parts), *Functional safety of electrical/electronic/programmable electronic safety-related systems*

IEC 61513, *Nuclear power plants – Instrumentation and control for systems important to safety – General requirements for systems*

IEC 62591, *Industrial communication networks – Wireless communication network and communication profiles – WirelessHART™*

IEC PAS 62734, *Industrial communication networks – Fieldbus specifications – Wireless systems for industrial automation: process control and related applications (Based on ISA 100.11a)*

3 Terms and definitions

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

3.1

access control

protection of system resources against unauthorized access; a process by which use of system resources is regulated according to a security policy and is permitted by only authorized entities (users, programs, processes, or other systems) according to that policy

3.2

authenticate

verify the identity of a user, user device, or other entity, or the integrity of data stored, transmitted, or otherwise exposed to unauthorized modification in an information system, or to establish the validity of a transmission