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Nuclear power plants – Instrumentation, control and electrical power systems – Guidance for the application of IEC 63147:2017/IEEE Std 497™-2016 in the IAEA / IEC framework

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FOREWORD

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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 63123, which is a technical report, 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 technical report is based on the following documents:

Enquiry draft	Report on voting
45A/1151/DTR	45A/1162A/RVDTR

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 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- withdrawn,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.

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

INTRODUCTION

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

October 2010, during the Seattle meeting WG A9 experts proposed the circulation of a NWIP to develop an IEC standard to coincide with IEEE 497 published in 2010, “IEEE Standard Criteria for accident Monitoring Instrumentation for Nuclear Power Generating Stations”, see 45A/828/RM.

July 2011, IEEE/NPEC informed IEC SC 45A of its decision to revise IEEE 497 in 2012 to take into account the recommendations made after the accident of Fukushima. IEEE/NPEC proposed this revision be made in cooperation with IEC SC 45A with the objective to publish an IEC/IEEE standard. The new IEEE 497 was to be prepared to have significant new technical content that reflects Fukushima lessons learned.

September 2011 SC 45A P-members were invited to review IEEE 497 published in 2010, see 45A/852/DC. The goal of this review was to identify the necessary changes to introduce in this IEEE standard during its revision to produce an IEC/IEEE standard, see 45A/864/INF.

February 2012, during the Karlsruhe IEC/IEEE projects meeting IEEE/NPEC/SC6 Champion presented information concerning the IEEE 497 and its foreseen revision. Following the debate held after the presentation it was confirmed that a restricted team of 4 IEC experts was to be set up by WG A9 for 3 or 4 e-meetings be held with 3 or 4 experts of IEEE to investigate on the possibility to launch a common revision.

April 2012, the IAEA initiated work on a Nuclear Energy Series document describing the rationale behind nuclear power plant accident monitoring systems and outlining the criteria for designated accident monitoring which is the subject of IEEE 497.

Fall 2012, the final report result of the IEC/IEEE expert team activities was sent to IEC SC 45A Secretariat. IEC SC 45A Secretary deeming that there was no sufficient elements to be reported to National Committees to ask them to approve or not the launching of the common revision of IEEE 497, decided to postpone the updating of 45A/864/INF.

2012-2013 the discussions continued between IEC and IEEE experts to try to solve the difficulties faced.

2013, during and after the Moscow meeting, IEEE NPEC and IEC SC 45A representatives discussed on how best to move forward. IEC SC 45A Chairman and Secretary proposed the IEEE NPEC develops its revision on its own sending the IEC SC 45A Secretariat the project drafts. It was proposed IEC SC 45A has those draft circulated to National Committee as DC, and the comments formulated by National Committees be circulated as INF letter, with the view to have a revised IEEE 497 which could be proposed to IEC for endorsement as dual logo standard in the frame of the agreement AC/138/2002.

Fall 2014, a first full draft of IEEE 497 was available for IEC consideration.

During the IEC IEEE joint projects meeting held the 2nd and 3rd of October 2014 in Las Vegas, the experts attending the IEC/IEEE joint projects meeting recommended, IEC SC 45A prepared for mid December 2014 an updated version of 45A/864/INF in order to inform IEC NCs of the effort done by IEEE/NPEC/SC6 during this revision of IEEE 497 and on the way the issues identified in 45A/864/INF were addressed.

Beginning 2015, IEC SC 45A prepared and circulated the updated version 45A/864A/INF. The objective of 45A/864A/INF was that the IEC NCs have the maximum of valid information if the IEEE decided upon completion of the revision of IEEE 497 to submit it to IEC for endorsement as dual logo standard in the frame of the agreement AC/138/2002.

March 2016 during the Gyeongju meetings, IEC SC 45A Secretary indicated that the setup of an IEC expert team will be necessary to analyze the revision of IEEE 497 if the IEEE decides to submit it. IEC SC 45A Secretary reminded also that all the IEC SC 45A experts were invited to volunteer to participate with them to the analysis if necessary, see 45A(Gyeongju/Secretariat)12.

End August 2016, IEC received the proposal of IEEE to endorse the IEEE 497 published in 2016 as dual logo standard in the frame of the agreement AC/138/2002.

September 2016, 45A/1108/DC circulated to fulfil the commitment taken in March 2016 in Gyeongju to set up a team of experts to review the revised IEEE 497 and to draft a recommendation to IEC for its endorsement.

December 2016 to February 2017, the team of expert reviewed IEEE 497:2016 and sent their comments to the IEC SC 45A Secretariat. Considering the comments submitted and the issues identified concerning the application of this edition of IEEE 497, following the advices of the IEC Central Office, the IEC SC 45A Secretariat supported by the team of expert drafted this Technical Report to support the application of the IEEE 497:2016 proposed for adoption at that time, in the IAEA/IEC framework.

August 2017, IEEE 497:2016 adoption as IEC 63147:2017/IEEE 497 was approved.

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

IEC TR 63123 as a technical report is by nature informative and is a fourth level document in in the IEC SC 45A standard series.

IEC TR 63123 is to be read in conjunction with IEC 63147:2017/IEEE 497 which in the IEC SC 45A standard series is considered as a third level 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 the document

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.

To ensure that the document 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 NPP; 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, defence 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 (NPP), the IAEA safety guide SSG-30 dealing with the safety classification of structures, systems and components in NPP, the IAEA safety guide SSG-39 dealing with the design of instrumentation and control systems for NPP, the IAEA safety guide SSG-34 dealing with the design of electrical power systems for NPP and the implementing 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 part 2 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 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 requirements 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, CONTROL AND ELECTRICAL POWER SYSTEMS – GUIDANCE FOR THE APPLICATION OF IEC 63147:2017/IEEE Std 497™-2016 IN THE IAEA / IEC FRAMEWORK

1 Scope

This document gives guidance for the application in the IAEA/IEC framework of the IEC 63147:2017/IEEE 497 corresponding to the adoption without modification of IEEE 497:2016.

During their review of IEEE 497:2016, the experts of the review team noted that between the 2010 edition of the IEEE 497 and its 2016 edition:

– some IEC standards were added as normative references;

– an additional group of Type F variables was defined to cover parameters providing information to manage fuel damage scenarios and associated technical requirements were given;

– several paragraphs were removed from 6.2 of the 2010 edition, which gave requirements on diversity of design and defence in depth;

– the term “1E” was replaced by “safety system”.

Nevertheless, two major issues for the possible direct adoption of IEEE 497:2016 as IEC/IEEE standard in the frame of the agreement AC/138/2002 were identified:

- The absence of reference to any function categorization scheme or system/equipment classification scheme.

NOTE In fact that issue corresponds to the fact that IEC 61226 is not referred and used in IEEE 497:2016.

- The identification terminology issues to consider.

The experts of the review team discussed technically those findings and IEC Central Office representative taking into account the discussion held in the review team advised the team to prepare this Technical Report to support their recommendation concerning the adoption of IEEE 497:2016 as IEC 63147:2017/IEEE 497 and to support its application in the IEC framework.

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/IEEE 60780-323:2016, *Nuclear facilities – Electrical equipment important to safety – Qualification*

IEC 60880:2006, *Nuclear power plants – Instrumentation and control systems important to safety – Software aspects for computer-based systems performing category A functions*

IEC 60980:1989, *Recommended practices for seismic qualification of electrical equipment of the safety system for nuclear generating stations*

IEC 61225:2005, *Nuclear power plants – Instrumentation and control systems important to safety – Requirements for electrical supplies*

IEC 61226, *Nuclear power plants – Instrumentation and control important to safety – Classification of instrumentation and control functions*

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

IEC 62138, *Nuclear power plants – Instrumentation and control important for safety – Software aspects for computer-based systems performing category B or C functions*

IEC 62340:2007*, Nuclear power plants – Instrumentation and control systems important to safety – Requirements for coping with common cause failure (CCF)*

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* (45A/1169/CC at the time of publication of this document)

IEC 62671, *Nuclear power plants – Instrumentation and control important to safety – Selection and use of industrial digital devices of limited functionality*

IEC 63147:2017/IEEE Std 497™-2016: *Criteria for accident monitoring instrumentation for nuclear power generating stations*

IAEA Safety Glossary, edition 2016

Remark: For the sake of consistency and the minimization of the probability of misinterpretation (due for example to problems of terminology), combining IEC and IEEE normative reference sets should be avoided as far as possible. In the documentation to be produced for an accident monitoring system it is important to note which normative reference set is used and to identify and justify if and how some external standards are used (e.g. issues related to terminology, classification/categorization, etc., in fact all the questions being addressed in this document).