Nuclear Power Plants

IAEA

60 Years

Atoms for Peace and Development

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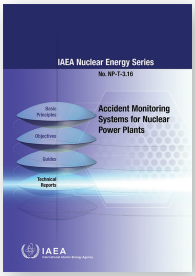
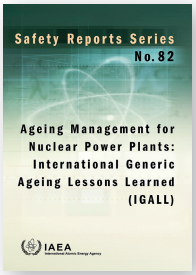


Accident Monitoring Systems for Nuclear Power Plants

IAEA Nuclear Energy Series No. NP-T-3.16

In the Fukushima Daiichi accident, the instrumentation provided for accident monitoring proved to be ineffective for a combination of reasons. The accident has therefore highlighted the need to re-examine criteria for accident monitoring instrumentation. This publication covers all relevant aspects of accident monitoring in nuclear power plants (NPPs). The critical issues discussed reflect the lessons learned from the Fukushima Daiichi accident, involve accident management and accident monitoring strategies for NPPs; selection of plant parameters for monitoring plant status; establishment of performance, design, qualification, display, and quality assurance criteria for designated accident monitoring instrumentation; and design and implementation considerations. Technology needs and techniques for accident monitoring instrumentation are also addressed.

(84 pp., 12 figs; 2015) • ISBN 978-92-0-110414-4 • STI/PUB/1676 • €32.00



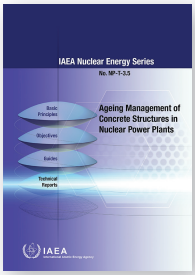
Ageing Management for Nuclear Power Plants: International Generic Ageing Lessons Learned (IGALL)

Safety Reports Series No. 82

This publication provides a common internationally agreed basis on what constitutes an acceptable ageing management programme, as well as a knowledge base on ageing management for the design of new plants and design and safety reviews, and aims to serve as a roadmap to available information on ageing management. It addresses ageing management of passive and active structures and components for water moderated reactors that can have an impact, directly or indirectly, on the safe operation of the plant and that are susceptible to ageing

degradation. The information provided is relevant for plants under normal operation, for plants considering long term operation, as well as for new plants including new designs. It underlines that ageing management should be implemented from the start of operation of nuclear power plants and that adequate provisions to facilitate effective ageing management should be made during the plant design, construction, commissioning, operation, and decommissioning.

(87 pp.; 2015) • ISBN 978-92-0-110214-0 • STI/PUB/1675 • €38.00

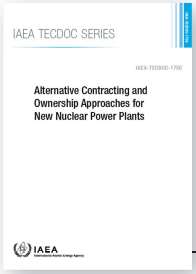


Ageing Management of Concrete Structures in Nuclear Power Plants

IAEA Nuclear Energy Series No. NP-T-3.5

This publication is one in a series of reports on the assessment and management of ageing of major nuclear power plant (NPP) components. Current practices for assessment of safety margins (fitness for service) and inspection, monitoring and mitigation of ageing related degradation of selected concrete structures related to NPPs are documented. Implications for and differences in new reactor designs are discussed. This information is intended to help all involved directly and indirectly in ensuring the safe operation of NPPs, and also to provide a common technical basis for dialogue between plant operators and regulators when dealing with age related licensing issues.

(355 pp., 211 figs; 2016) • ISBN 978-92-0-102914-0 • STI/PUB/1654 • €55.00



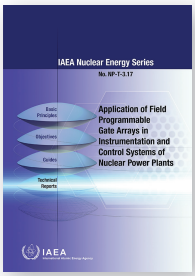
Alternative Contracting and Ownership Approaches for New Nuclear Power Plants

IAEA TECDOC Series No. 1750

This publication examines alternative contracting and ownership approaches

for the development, construction, commissioning, operation and decommissioning of new nuclear power plants. It identifies issues faced by IAEA Member States considering the applicability of such approaches to their respective national programmes. Two new approaches to nuclear project development are analysed. These are, firstly, the Build-Own-Operate (BOO)/Build-Own-Operate-Transfer (BOO(T)) and, secondly, regional approaches. The information includes practical examples, current practices and case studies, and reflects the presentations and discussions that took place in a series of IAEA meetings on this topic.

**(2014) • ISBN 978-92-0-108314-2 •
IAEA-TECDOC-1750 • €18.00**

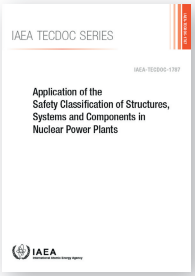


Application of Field Programmable Gate Arrays in Instrumentation and Control Systems of Nuclear Power Plants

IAEA Nuclear Energy Series No. NP-T-3.17

Field programmable gate arrays (FPGAs) are gaining increased attention worldwide for application in nuclear power plant (NPP) instrumentation and control (I&C) systems, particularly for safety and safety related applications, but also for non-safety ones. NPP operators and equipment suppliers see potential advantages of FPGA based digital I&C systems as compared to microprocessor based applications. This is because FPGA based systems can be made simpler, more testable and less reliant on complex software (e.g. operating systems), and are easier to qualify for safety and safety related applications. This publication results from IAEA consultancy meetings covering the various aspects, including design, qualification, implementation, licensing, and operation, of FPGA based I&C systems in NPPs.

**(80 pp., 6 figs; 2016) • ISBN 978-92-0-103515-8 •
STI/PUB/1701 • €33.00**

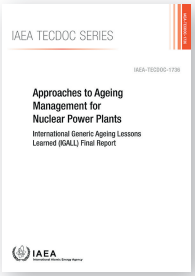


Application of the Safety Classification of Structures, Systems and Components in Nuclear Power Plants

IAEA TECDOC Series No. 1787

This publication describes how to complete tasks associated with every step of the classification methodology set out in IAEA Safety Standards Series No. SSG-30, Safety Classification of Structures, Systems and Components in Nuclear Power Plants. In particular, how to capture all the structures, systems and components (SSCs) of a nuclear power plant to be safety classified. Emphasis is placed on the SSCs that are necessary to limit radiological releases to the public and occupational doses to workers in operational conditions. This publication provides information for organizations establishing a comprehensive safety classification of SSCs compliant with IAEA recommendations, and to support regulators in reviewing safety classification submitted by licensees.

**(2016) • ISBN 978-92-0-101116-9 •
IAEA-TECDOC-1787 • €18.00**



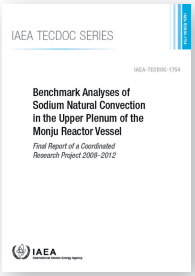
Approaches to Ageing Management for Nuclear Power Plants

International Generic Ageing Lessons Learned (IGALL) Final Report

IAEA TECDOC Series No. 1736

This publication complements the IAEA Safety Report on proven ageing management programmes, the main deliverable of the International Generic Ageing Lessons Learned for Nuclear Power Plants, and presents a summary of the national approaches taken by Member States.

**(2014) • ISBN 978-92-0-104414-3 •
IAEA-TECDOC-1736 • €18.00**



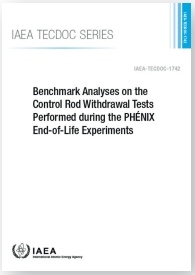
Benchmark Analyses of Sodium Natural Convection in the Upper Plenum of the Monju Reactor Vessel

Final Report of a Coordinated Research Project 2008–2012

IAEA TECDOC Series No. 1754

This publication documents the main achievements and results of the benchmark analyses performed during an IAEA coordinated research project (CRP). The goal of the CRP was to improve analytical capabilities in the field of reactor vessel thermal hydraulics in sodiumcooled fastreactors (SFRs). The CRP benefitted from the experimental data concerning a turbine trip transient test conducted in 1995 on the Monju SFR, provided by the Japan Atomic Energy Agency

(2014) • ISBN 978-92-0-109614-2 • IAEA-TECDOC-1754 • €18.00



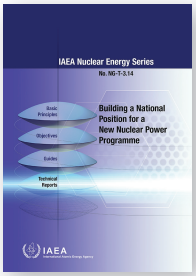
Benchmark Analyses on the Control Rod Withdrawal Tests Performed during the PHÉNIX End-of-Life Experiments

IAEA TECDOC Series No. 1742

This publication is based on the experience of an IAEA coordinated research project on control rod withdrawal and sodium natural circulation tests performed during the Phénix end-of-life experiments. The publication presents benchmark analyses on the control rod withdrawal tests. The experimental data gathered during these tests represent a unique resource for validation analyses and code-to-code comparisons. The benchmark analyses allowed participants to investigate and verify neutronics codes used in the analysis of sodium cooled fast reactor cores, as far as their capability to correctly evaluate relevant safety aspects such as control rod

efficiency and core power deformation due to the insertion and withdrawal of control rods.

**(2014) • ISBN 978-92-0-105314-5 •
IAEA-TECDOC-1742 • €18.00**



Building a National Position for a New Nuclear Power Programme

IAEA Nuclear Energy Series No. NG-T-3.14

This publication provides guidance to countries seeking to establish a national position on the introduction or re-establishment of a nuclear power programme. It provides direction to political decision makers, energy experts, and other stakeholders about the process for establishing a national position as countries prepare national nuclear energy policies. It also helps embarking countries to build a consistent and durable national position for nuclear power on the basis of sound energy planning and greater public involvement in order to maintain the country's long term commitment, regardless of possible political changes in a country.

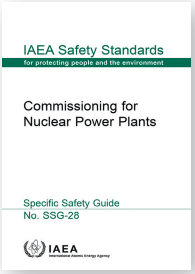
**(19 pp., 2 figs; 2016) • ISBN 978-92-0-102216-5 •
STI/PUB/1736 • €20.00**

Buried and Underground Piping and Tank Ageing Management for Nuclear Power Plants

IAEA Nuclear Energy Series No. NP-T-3.20

This publication is one in a series of reports on the assessment and management of ageing of the major nuclear power plant (NPP) components. It deals with buried and underground piping and tank systems that are included as part of an NPP and addresses potential ageing mechanisms, age related degradation, and ageing management as well as condition assessments for the material and components of such systems. The intended target audience for this publication are NPP owners, operators, designers, engineers and specialists.

**(Forthcoming) • ISBN 978-92-0-102116-8 •
STI/PUB/1735 • €60.00**



Commissioning for Nuclear Power Plants

Specific Safety Guide

IAEA Safety Standards Series No. SSG-28

This Safety Guide provides recommendations on the basis of international best practices, as currently followed in IAEA Member States, on how to meet commissioning requirements for nuclear power plants. These requirements enable the commissioning of a nuclear power plant to proceed safely and to a high quality. The recommendations will also enable the necessary assurances to be provided that the plant has been constructed in accordance with the design intent and can be operated safely.

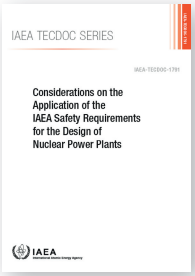
English Edition (84 pp., 2 figs; 2014) • ISBN 978-92-0-140110-6 • STI/PUB/1595 • €40.00
Russian Edition (104 pp., 2 figs; 2016) • ISBN 978-92-0-406016-4 • STI/PUB/1595 • €40.00

Commissioning Guidelines for Nuclear Power Plants

IAEA Nuclear Energy Series No. NP-T-2.10

Commissioning is one of the key steps towards putting into service a new nuclear facility, or a new system, structure or component within an existing facility. Commissioning activities need to be planned early in the design and procurement process, with careful consideration of eventual acceptance criteria and test methods. This publication describes commissioning in its basic form, the commissioning process specific to nuclear power plants (NPPs), the relevant management system requirements, typical organizational models and critical human resources issues. It also provides details on experience and lessons learned obtained in IAEA Member States. The publication will be of use to all stakeholders involved in the commissioning of NPPs, including owner operators, contractors, engineers, regulatory bodies and vendors.

(Forthcoming) • ISBN 978-92-0-102816-7 • STI/PUB/1742 • €48.00

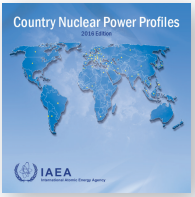


Considerations on the Application of the IAEA Safety Requirements for the Design of Nuclear Power Plants

IAEA TECDOC Series No. 1791

This publication facilitates the understanding and practical application of the IAEA Safety Requirements for the Design of Nuclear Power Plants, SSR 2/1 (Rev. 1), which has been revised after the Fukushima Daiichi accident to strengthen the safety of the plant designs. It addresses in particular some novel requirements and concepts in SSR-2/1 (Rev. 1), that due to the complexity of the topics could lead to different interpretations. The publication is intended to clarify them in order to contribute to the harmonization of approaches and to coalesce or minimize diverging views.

**(2016) • ISBN 978-92-0-104116-6 •
IAEA-TECDOC-1791 • €18.00**

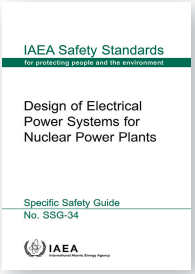


Country Nuclear Power Profiles

2016 Edition

The Country Nuclear Power Profiles compile background information on the status and development of nuclear power programmes in Member States. The publication summarizes organizational and industrial aspects of nuclear power programmes and provides information about the relevant legislative, regulatory and international framework in each State. Its descriptive and statistical overview of the overall economic, energy and electricity situation in each State and its nuclear power framework is intended to serve as an integrated source of key background information about nuclear power programmes throughout the world. This 2016 edition, issued on CD-ROM, contains updated country information for 51 States.

**(2016) • ISBN 978-92-0-156916-5 •
IAEA-CNPP/2016/CD • €95.00**



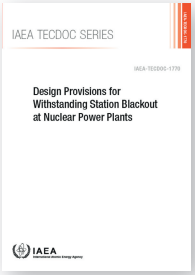
Design of Electrical Power Systems for Nuclear Power Plants

Specific Safety Guide

IAEA Safety Standards Series No. SSG-34

This Safety Guide provides recommendations on the necessary characteristics of electrical power systems for nuclear power plants, and of the processes for developing these systems, in order to meet the safety requirements of IAEA Safety Standards Series No. SSR-2/1 (Rev. 1). It reflects the changes that have been made to SSR-2/1, in particular to Requirement 68 on emergency power supply.

(120 pp., 9 figs; 2016) • ISBN 978-92-0-109314-1 • STI/PUB/1673 • €47.00

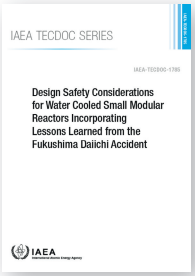


Design Provisions for Withstanding Station Blackout at Nuclear Power Plants

IAEA TECDOC Series No. 1770

This publication provides information for new plant designs as well as modifications to existing operating nuclear power plants to cope with extended station blackout. It describes a common international technical basis to be considered when establishing all the criteria for a station blackout event, and outlines critical issues which reflect the lessons learned applicable to electrical systems from the Fukushima Daiichi accident. The publication describes current plant practices and design provisions for withstanding a station blackout event already implemented at some nuclear power plants. It also provides proposals for improvement of existing plant designs to increase the robustness of the electrical power systems for contending with a station blackout event.

(2015) • ISBN 978-92-0-106415-8 • IAEA-TECDOC-1770 • €18.00

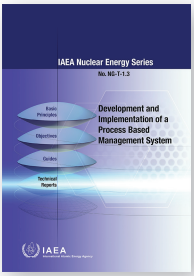


Design Safety Considerations for Water Cooled Small Modular Reactors Incorporating Lessons Learned from the Fukushima Daiichi Accident

IAEA TECDOC Series No. 1785

This publication presents technology developers and users with common considerations, approaches and measures for enhancing the defence in depth and operability of water cooled small modular reactor (SMR) design concepts to cope with extreme natural hazards. Indicative requirements to prevent an accident such as the Fukushima Daiichi accident from recurring are also provided for States planning to adopt water cooled SMR designs and technologies. This publication was produced within the framework of the IAEA Action Plan on Nuclear Safety, specifically under item 12 on effectively utilizing research and development..

(2016) • ISBN 978-92-0-100716-2 • IAEA-TECDOC-1785 • €18.00



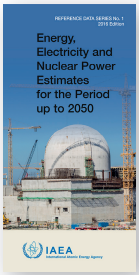
Development and Implementation of a Process Based Management System

IAEA Nuclear Energy Series No. NG-T-1.3

The implementation of a process based management system is challenging for many organizations accustomed to traditional, non-integrated, non-process based approaches to management systems. This publication provides practical guidance to nuclear organizations that are planning to implement a management system to comply with IAEA Safety Standards Series No. GS-R-3. It will also be beneficial for newcomer countries, since a vendor-provided “management system” delivered with a nuclear power plant to ensure safe operation is often a quality management system for operations and maintenance, which may integrate aspects related

to safety and environmental protection. These quality assurance systems have to undergo a transition to a process based management system to ensure that the processes of the owner/operator will be tailored to achieve the goals and objectives for safe operation.

(57 pp., 17 figs; 2015) • ISBN 978-92-0-103215-7 • STI/PUB/1698 • €34.00



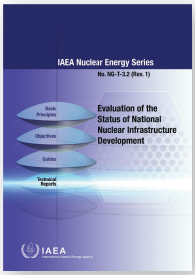
Energy, Electricity and Nuclear Power Estimates for the Period up to 2050

2016 Edition

Reference Data Series No. 1

The 36th edition of the annual Reference Data Series No. 1 contains estimates of energy, electricity and nuclear power trends up to the year 2050, using a variety of sources, such as the IAEA's Power Reactor Information System and data prepared by the United Nations.

(53 pp., 10 figs; 2016) • ISBN 978-92-0-106816-3 • IAEA-RDS-1/36 • €18.00



Evaluation of the Status of National Nuclear Infrastructure Development

IAEA Nuclear Energy Series No. NG-T-3.2 (Rev. 1)

This publication provides a holistic approach to evaluate progress in the development of the nuclear power infrastructure based on the guidance contained in the IAEA Nuclear Energy Series No. NG-G-3.1, Milestones in the Development of a National Infrastructure for Nuclear Power. It can be used by a Member State itself, wishing to evaluate its progress (self-evaluation), or as a basis for an integrated nuclear infrastructure review (INIR) mission. This revised version combines in one document an explanation of the methodology and the evaluation tables, takes into account all new material and lessons learned from the Fukushima Daiichi accident, and presents the

results of the INIR missions implemented between 2009 and 2014.

(69 pp., 1 fig., 2017) • ISBN 978-92-0-102316-2 • STI/PUB/1737 • €29.00

Fast Reactors and Related Fuel Cycles: Safe Technologies and Sustainable Scenarios (FR13)

Proceedings of an International Conference Held in Paris, France, 4–7 March, 2 volumes

Proceedings Series

This publication presents the proceedings of an international conference in the field of fast reactors and related fuel cycle technologies. The conference provided a unique forum to discuss national and international fast reactor programmes, analyse new experience and advances arising from research and development programmes, and identify needs to be addressed in relation to the industrial deployment of fast reactors. A CD-ROM with invited papers and contributed papers accompanies this publication and is available on this website. The papers in these Proceedings were peer reviewed by members of the International Scientific Programme Committee.

(519 pp., 168 figs; 2015) • ISBN 978-92-0-104114-2 • STI/PUB/1665 • €98.00

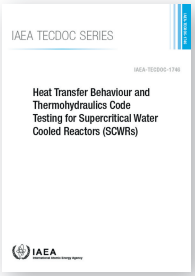
Handbook of Ageing Management for Nuclear Power Plants

IAEA Nuclear Energy Series No. NP-T-3.24

This handbook on ageing management for nuclear power plants (NPPs) has been developed in compliance with relevant IAEA Safety Standards and draws on lessons learned from ageing management practices worldwide. It provides an overview of the topic and guidance on proactive ageing management within NPPs. The publication also collates information on ageing mechanisms, effects on structures, systems and components, the regulatory framework as well as some details on innovative

techniques and research and development in the area. The information is presented concisely with clear flow charts and with structured reference to the underlying principles. The handbook will support NPP staff, maintenance managers, vendors, personnel at research organizations and regulators in their work related to the ageing of structures, systems and components.

(Forthcoming) • ISBN 978-92-0-102416-9 • STI/PUB/1738 • €48.00

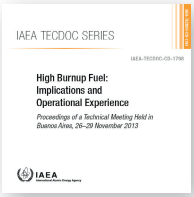


Heat Transfer Behaviour and Thermohydraulics Code Testing for Supercritical Water Cooled Reactors (SCWRs)

IAEA TECDOC Series No. 1746

In order to develop the supercritical water cooled reactor (SCWR) concept, thermohydraulics of supercritical pressure water is one of the most important areas to be clarified. This publication summarizes the outcome of an IAEA coordinated research project (CRP) on this topic. It provides researchers and engineers with a comprehensive and reliable thermohydraulics database and the current status of prediction methods for SCWR concept development. The publication includes descriptions of SCWR concepts, heat transfer and pressure loss characteristics of supercritical pressure fluids, development of new heat transfer prediction methods, critical flow during depressurization from supercritical conditions, and flow stability and natural circulation in supercritical pressure systems. It also covers the results of two code testing benchmark exercises for steady state heat transfer and flow stability in a heated channel.

(2014) • ISBN 978-92-0-107614-4 • IAEA-TECDOC-1746 • €18.00



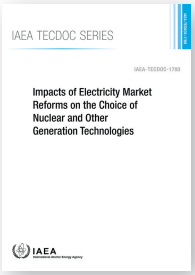
High Burnup Fuel: Implications and Operational Experience

Proceedings of a Technical Meeting Held in Buenos Aires, 26–29 November 2013

IAEA TECDOC Series No. 1798

This publication reports on the outcome of a technical meeting on high burnup fuel experience and economics, held in Buenos Aires, Argentina in 2013. The purpose of the meeting was to revisit and update the current operational experience and economic conditions associated with high burnup fuel. International experts with significant experience in experimental programmes on high burnup fuel discussed and evaluated physical limitations at pellet, cladding and structural component levels, with a wide focus including fabrication, core behaviour, transport and intermediate storage for most types of commercial nuclear power plants.

(2016) • ISBN 978-92-0-155316-4 • IAEA-TECDOC-CD-1798 • €18.00



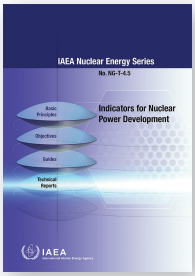
Impacts of Electricity Market Reforms on the Choice of Nuclear and Other Generation Technologies

IAEA TECDOC Series No. 1789

Electricity market reforms have been underway worldwide for the last 20 years. They have included restructuring, privatization, regulation and the introduction of market mechanisms in electricity generation and trading. This publication analyses the impacts of these reforms as well as non-reform factors, on the selection of electricity generation technologies, including nuclear power, by investors. A country case study approach has been adopted in developing the material presented in the publication. Each case study is organized around the following themes: rationale for reform; nature of the electricity market reform; how has the reform shaped the allocation of investment risk in electricity markets and

how has this risk allocation influenced investor choice of generation technologies; and finally, how have non-reform related factors influenced investors' choice. This publication will be of use by stakeholders in the strategic planning of the electricity sector, including policy makers, policy analysts, policy advisors, power sector regulators and utility operators.

(2016) • ISBN 978-92-0-103916-3 • IAEA-TECDOC-1789 • €18.00

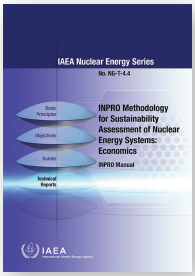


Indicators for Nuclear Power Development

IAEA Nuclear Energy Series No. NG-T-4.5

Considering the scale of nuclear power aspirations, the number of planned nuclear new builds and the prospects of a number of countries constructing their first nuclear power plants, there is a need to assess the broader context of nuclear energy programmes in areas of macro-and socioeconomic conditions, energy systems and nuclear power, and the environment. It is important to assess the degree to which introduction or expansion of nuclear power is beneficial under these specific circumstances. This publication provides a set of indicators for nuclear power development that can serve as a tool to help explore these issues. The indicators are meant to provide a first order assessment of the situation and identify the issues that present the benefits and challenges in a balanced and objective manner and thereby help guide more detailed evaluations in the next stage of planning and preparations. Methodology sheets are provided to help users in data collection, quantification and interpretation of the indicators. The application of the indicators set is flexible. Users can select a subset of indicators that are most relevant for the questions they wish to explore in a given study or decision making process.

(93 pp., 4 figs; 2015) • ISBN 978-92-0-107115-6 • STI/PUB/1712 • €37.00



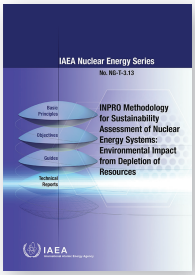
INPRO Methodology for Sustainability Assessment of Nuclear Energy Systems: Economics

INPRO Manual

IAEA Nuclear Energy Series No. NG-T-4.4

As part of the INPRO methodology this manual provides guidance on assessing a nuclear energy system in the area of economics. This is an independent assessment of the economic competitiveness of nuclear power, compared with available alternatives. The publication starts with a short description of the goals and output of an energy system planning study, followed by general background information on performing an INPRO economic assessment, and presents a discussion of the basic principles and the associated user requirements and criteria. In the appendices, additional background information on economic terms and support tools is provided.

(90 pp.; 2014) • ISBN 978-92-0-102714-6 • STI/PUB/1653 • €40.00



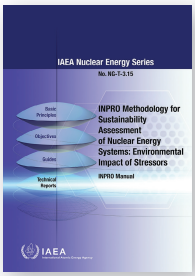
INPRO Methodology for Sustainability Assessment of Nuclear Energy Systems: Environmental Impact from Depletion of Resources

IAEA Nuclear Energy Series No. NG-T-3.13

INPRO is an international project to help ensure that nuclear energy is available to contribute in a sustainable manner to meeting the energy needs of the 21st century. A basic principle of INPRO in the area of environmental impact from depletion of resources is that a nuclear energy system will be capable of contributing to the energy needs in the 21st century while making efficient use of non-renewable resources needed for construction, operation and decommissioning. Recognizing that a

national nuclear energy programme in a given country may be based both on indigenous resources and resources purchased from abroad, this publication provides background materials and summarizes the results of international global resource availability studies that could contribute to the corresponding national assessments.

(62 pp., 25 figs; 2015) • ISBN 978-92-0-103415-1 • STI/PUB/1700 • €33.00



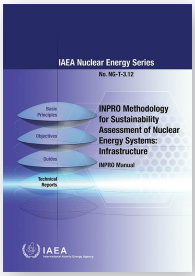
INPRO Methodology for Sustainability Assessment of Nuclear Energy Systems: Environmental Impact of Stressors

INPRO Manual

IAEA Nuclear Energy Series No. NG-T-3.15

This publication provides guidance on assessing of sustainability of a nuclear energy system (NES) in the area of environmental impact of stressors. The INPRO methodology is a comprehensive tool for the assessment of sustainability of an NES. Basic principles, user requirements and criteria have been defined in different areas of INPRO methodology. These include economics, infrastructure, waste management, proliferation resistance, environmental impact of stressors, environmental impact from depletion of resources, and safety of nuclear reactors and fuel cycle facilities. The ultimate goal of the application of the INPRO methodology is to check whether the assessed NES fulfils all the criteria, and hence the user requirements and basic principles, and therefore presents a system for a Member State that is sustainable in the long term.

(94 pp., 5 figs; 2016) • ISBN 978-92-0-101616-4 • STI/PUB/1733 • €38.00



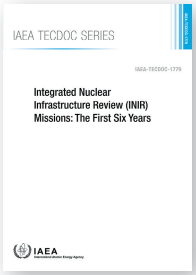
INPRO Methodology for Sustainability Assessment of Nuclear Energy Systems: Infrastructure

INPRO Manual

IAEA Nuclear Energy Series No. NG-T-3.12

This publication is an update of the guidance given in the area of infrastructure in Volume 3 of IAEA-TECDOC-1575 Rev.1 (2008), Guidance for the Application of an Assessment Methodology for Innovative Nuclear Energy Systems. It is based on recommendations presented by Member States participating in INPRO, IAEA experts and the IAEA INPRO group. The publication provides guidance on assessing a nuclear energy system in the area of nuclear infrastructure. Within the INPRO methodology, a nuclear infrastructure can be defined as the collection of necessary capabilities of national institutions to achieve long term sustainability of a nuclear power programme. Several aspects are discussed in detail in this publication, in particular the importance of public acceptance of a nuclear power programme and the necessary human resources to establish and operate such a programme. Additionally, INPRO methodology defines measures that a designer and the state should take to reduce the necessary effort to establish and maintain a nuclear infrastructure.

(68 pp.; 2014) • ISBN 978-92-0-106214-7 • STI/PUB/1668 • €33.00



Integrated Nuclear Infrastructure Review (INIR) Missions: The First Six Years

IAEA TECDOC Series No. 1779

The IAEA Integrated Nuclear Infrastructure Review (INIR) missions are designed to assist Member States in evaluating the status of their national infrastructure for the introduction of a nuclear power

programme. From 2009 to 2014, fourteen IAEA INIR missions and follow-up activities were conducted in nine countries planning to implement a nuclear power programme and one country expanding an existing programme. During this time considerable experience was gained and this has been used to continuously improve the overall INIR methodology. This publication summarizes the results of the missions and highlights the most significant areas where recommendations were made.

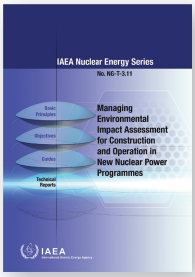
**(2015) • ISBN 978-92-0-110615-5 •
IAEA-TECDOC-1779 • €18.00**

Maintenance Optimization Programme for Nuclear Power Plants

IAEA Nuclear Energy Series No. NP-T-3.8

This publication deals with the latest nuclear power plant maintenance optimization programmes and provides key requirements and strategies for successful implementation. It documents shared proven maintenance optimization methods and techniques from IAEA Member States, including more detailed examples in the annexes of this publication.

**(Forthcoming) • ISBN 978-92-0-110916-3 •
STI/PUB/1757 • €39.00;**



Managing Environmental Impact Assessment for Construction and Operation in New Nuclear Power Programmes

IAEA Nuclear Energy Series No. NG-T-3.11

This publication provides a holistic approach to environmental protection in new nuclear power programmes. It describes the environmental impact assessment (EIA) process, the subsequent utilization of the EIA, and the necessary infrastructure for such processes. The presumption is that a Member State embarking on such a programme already has an environmental regulatory framework in

place, which may not be developed for nuclear power but instead for industrial projects; therefore the emphasis is on the environmental aspects that are unique to a nuclear power plant project. The publication is addressed to senior managers, project managers or coordinators and technical specialists of government authorities and agencies, including the regulatory body, operating organizations and supporting industries and other organizations involved in environmental issues.

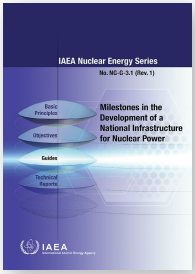
(47 pp., 8 figs; 2014) • ISBN 978-92-0-144810-1 • STI/PUB/1625 • €29.00

Managing the Financial Risk Associated with the Financing of New Nuclear Power Plant Projects

IAEA Nuclear Energy Series No. NG-T-4.6

Mitigation of the financial risks attendant on a nuclear power plant new-build project is a key to ensuring project viability. This publication emphasizes how various risks – including those typically considered to be 'engineering risks' - will give rise to such financial risks. It then introduces the linkage between efficient financial risk allocation/ mitigation and the cost of capital, and sets out a range of mechanisms which can be used to manage and allocate risks efficiently — thereby minimizing the cost of capital and enhancing project economics. At a practical level the publication provides an insight into the concerns, modes of thinking, and language which a nuclear new-build proponent may expect to encounter within the financing community as they seek to develop their project.

(Forthcoming) • ISBN 978-92-0-100317-1 • STI/PUB/1765 • €32.00



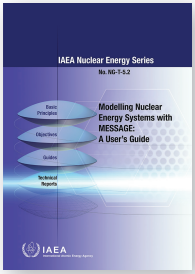
Milestones in the Development of a National Infrastructure for Nuclear Power

IAEA Nuclear Energy Series No. NG-G-3.1 (Rev. 1)

The development and implementation of an appropriate infrastructure to

support the successful introduction of nuclear power and its safe, secure, peaceful and sustainable application is an issue of central concern, especially for countries that are considering and planning their first nuclear power plant. In preparing the necessary nuclear infrastructure, there are several activities that need to be completed. These activities can be split into three progressive phases of development. This publication provides a description of the conditions expected to be achieved by the end of each phase to assist with the best use of resources. 'Milestones' refer to the conditions necessary to demonstrate that the phase has been successfully completed.

(79 pp., 1 fig.; 2015) • ISBN 978-92-0-104715-1 • STI/PUB/1704 • €40.00



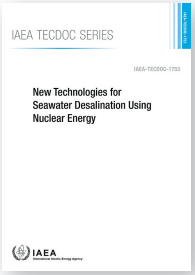
Modelling Nuclear Energy Systems with MESSAGE: A User's Guide

IAEA Nuclear Energy Series No. NG-T-5.2

Assessing nuclear energy transition scenarios requires appropriate modelling tools. The IAEA tool, Model for Energy Supply System Alternatives and their General Environmental Impacts (MESSAGE), is described in this publication. The tool simulates the development of a complete energy system and provides a convenient platform for modelling and analysing nuclear energy systems (NESs), as it can efficiently model nuclear technologies with their specific features. Among other things, the tool can help produce a description of an entire NES with time dependent parameters for long-term planning; confirm the feasibility of a NES through correlation and consistency of all NES components, taking into account all constraints and boundary conditions imposed on the system; and balance fissile material in a closed fuel cycle and determine fuel cycle requirements. In addition, it assists the user in the choice of alternatives by comparison of different options relating to fuel requirements and volume and toxicity of

waste. The publication provides a detailed guidance on how to build mathematical models representing complex nuclear energy systems within the framework of the MESSAGE tool.

(126 pp., 110 figs; 2016) • ISBN 978-92-0-109715-6 • STI/PUB/1718 • €39.00



New Technologies for Seawater Desalination Using Nuclear Energy

IAEA TECDOC Series No. 1753

This publication compiles the findings of research and development activities relating to new technologies to support seawater desalination using nuclear energy. An overview of current progress on low temperature technologies for seawater desalination is included. The publication also provides information on competitiveness and sustainability of seawater desalination using nuclear energy and a techno-economic feasibility study of nuclear desalination.

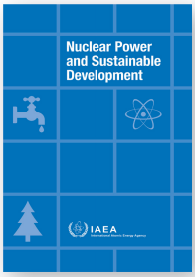
(2015) • ISBN 978-92-0-100115-3 • IAEA-TECDOC-1753 • €18.00

Non-Baseload Operations in Nuclear Power Plants: Load Following and Frequency Control Modes of Flexible Operations

IAEA Nuclear Energy Series No. NP-T-3.23

This publication aims to address all relevant aspects of flexible operation of nuclear power plants (NPPs) specifically focusing on changing electrical output to match the electrical demand and to control the frequency of the electrical system, termed as ‘load following’ and ‘frequency control’. It is intended to provide collective guidance, based on current knowledge and operational experience, for the decision making and implementation of flexible operation for Member States who are considering future flexible operations of their NPPs.

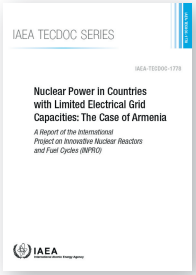
(Forthcoming) • ISBN 978-92-0-110816-6 • STI/PUB/1756 • €40.00



Nuclear Power and Sustainable Development

Transforming the energy system is at the core of the dedicated sustainable development goal on energy within the new United Nations development agenda. This publication explores the possible contribution of nuclear energy to addressing the issues of sustainable development through a large selection of indicators. It reviews the characteristics of nuclear power in comparison with alternative sources of electricity supply, according to economic, social and environmental pillars of sustainability. The findings summarized in this publication will help the reader to consider, or reconsider, the contribution that can be made by the development and operation of nuclear power plants in contributing to more sustainable energy systems.

(116 pp., 31 figs; 2016) • ISBN 978-92-0-107016-6 • STI/PUB/1754 • €45.00



Nuclear Power in Countries with Limited Electrical Grid Capacities: The Case of Armenia

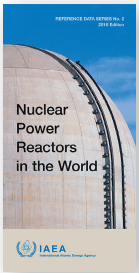
A Report of the International Project on Innovative Nuclear Reactors and Fuel Cycles (INPRO)

IAEA TECDOC Series No. 1778

This publication addresses issues relating to nuclear power deployment faced by countries with electrical grids of limited capacity and stability. In particular, technology issues and related institutional measures as well as some technical and economic options for managing spent fuel and radioactive waste applicable in these circumstances are addressed. It aims to assist States implementing a nuclear power programme in the development of a comprehensive approach to the long term management of spent nuclear fuel and radioactive waste that is technically sound, environmentally responsible, economically feasible and acceptable to

all stakeholders. Armenia was selected as a case study and the data obtained from the studies performed led to general recommendations which could be applicable to some other countries with similar economies and grid characteristics.

**(2015) • ISBN 978-92-0-110415-1 •
IAEA-TECDOC-1778 • €18.00**



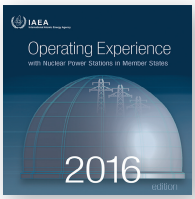
Nuclear Power Reactors in the World

2016 Edition

Reference Data Series No. 2

This is the 36th edition of Reference Data Series No. 2, which presents the most recent reactor data available to the IAEA. It contains summarized information as of the end of 2015 on power reactors operating, under construction and shut down as well as performance data on reactors operating in the IAEA Member States. The information is collected through designated national correspondents in the Member States and the data are used to maintain the IAEA's Power Reactor Information System (PRIS).

**(2016) • ISBN 978-92-0-103716-9 •
IAEA-RDS-2/36 • €15.00**



Operating Experience with Nuclear Power Stations in Member States

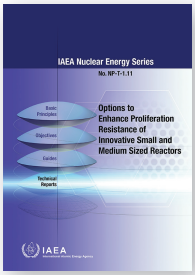
2016 Edition

Operating Experience

This CD-ROM contains the 47th edition of the IAEA's series of annual reports on operating experience with nuclear power plants in Member States. It is a direct output from the IAEA's Power Reactor Information System (PRIS) and contains information on electricity production and overall performance of individual plants during 2015. In addition to annual information, the report contains a historical summary of performance during the lifetime of individual plants and figures illustrating worldwide performance of the nuclear

industry. The CD-ROM contains also an overview of design characteristics and dashboards of all operating nuclear power plants worldwide.

CD Edition 2016 • ISBN 978-92-0-155016-3 • STI/PUB/1752 • €75.00

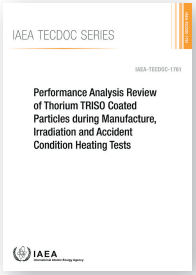


Options to Enhance Proliferation Resistance of Innovative Small and Medium Sized Reactors

IAEA Nuclear Energy Series No. NP-T-1.11

This publication addresses specific considerations for proliferation resistance and safeguards for small and medium sized reactors (SMRs). It describes the framework analysis through comparing and harmonizing the Generation IV International Forum and the International Project on Innovative Nuclear Reactors and Fuel Cycles methodologies, defines the proliferation resistance assessment and safeguards by design approach and presents the current implementation of proliferation resistance measures in innovative SMRs. The appendices include information on the example of a procedure to support a facility's analysis of the safeguarding situation in support of safeguards by design, and a template listing required proliferation resistance related design information. An overview of SMR design and development activities and state perspectives is given in the annexes.

(63 pp., 2 figs; 2014) • ISBN 978-92-0-145510-9 • STI/PUB/1632 • €28.00



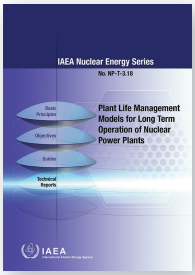
Performance Analysis Review of Thorium TRISO Coated Particles during Manufacture, Irradiation and Accident Condition Heating Tests

IAEA TECDOC Series No. 1761

This publication is the outcome of an IAEA coordinated research project on near term and promising long term options for

deployment of thorium based nuclear energy. It is based on the compilation and analysis of available results on thorium tristructural isotropic (TRISO) coated particle fuel performance in manufacturing during irradiation and accident condition heating tests. As a result, the project participants concluded that the performance statistics for the high enriched thoria urania TRISO fuel system are in perfect concert with those state of the art requirements for present day high temperature reactor concepts.

**(2015) • ISBN 978-92-0-100715-5 •
IAEA-TECDOC-1761 • €18.00**



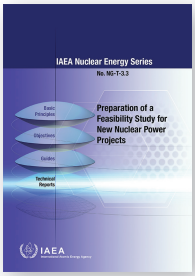
Plant Life Management Models for Long Term Operation of Nuclear Power Plants

IAEA Nuclear Energy Series No. NP-T-3.18

When nuclear power plants reach the end of their nominal design life, they undergo a special safety review and an ageing assessment of their essential structures, systems and components for the purpose of validating or renewing their licence to operate for terms beyond the service period originally intended. Three different plant life management models have been used to qualify these nuclear power plants to operate beyond their original design life. This publication presents a collection of sample licensing practices for long term operation among IAEA Member States. The various plant life management models used to obtain long term operation authorizations are described and comparisons drawn against the standard periodic safety review model. Lessons learned and warnings about possible complications and pitfalls are also described to minimize the licensing risk during operation and future long term operation applications. The main intention of this publication is to support nuclear power plant owners and operators planning an extension of plant operation beyond its original design life, but it also serves as a useful guide for those interested in procuring, from the beginning, the necessary tools to implement

ageing management in their future plant with long term operation in mind.

(134 pp., 43 figs; 2015) • ISBN 978-92-0-103014-6 • STI/PUB/1655 • €38.00

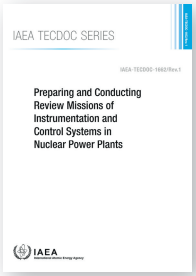


Preparation of a Feasibility Study for New Nuclear Power Projects

IAEA Nuclear Energy Series No. NG-T-3.3

A feasibility study represents an important step in the development of a new build nuclear power plant project. It is a complex but necessary step to determine whether a business opportunity is possible, practical and viable. Technical, economic, financial, regulatory, social and environmental aspects of a nuclear power plant programme need to be considered to allow authorities to make informed decisions regarding the possible implementation of the project. This publication assists Member States in developing a feasibility study for nuclear power projects and provides guidance to users who are planning to perform such a study, with consideration of both the technical and process areas. These guidelines condense the experience of individuals involved in previous feasibility study efforts and provide industry best practices in order to maximize the usefulness of any results.

(125 pp., 10 figs; 2014) • ISBN 978-92-0-145610-6 • STI/PUB/1633 • €39.00



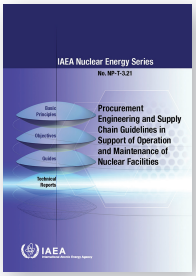
Preparing and Conducting Review Missions of Instrumentation and Control Systems in Nuclear Power Plants

IAEA TECDOC Series No. 1662/ Rev. 1

The IERICS (Independent Engineering Review of Instrumentation and Control Systems) mission is a comprehensive engineering review service directly addressing strategy and the key elements

for implementation of modern instrumentation and control (I&C) systems, noting in applicable cases, specific concerns related to the implementation of advanced digital I&C systems and the use of software and/or digital logic in safety applications of a nuclear power plant. The guidelines outlined in this publication provide a basic structure, common reference and checklist across the various areas covered by an IERICS mission. Publications referenced in these guidelines could provide additional useful information for the counterpart while preparing for the IERICS mission. A structure for the mission report is given in the Appendix. In 2016, this publication was revised by international experts who had participated in previous IERICS missions. The revision reflects experiences and lessons learned from the preparation and conduct of those missions.

**(2016) • ISBN 978-92-0-105816-4 •
IAEA-TECDOC-1662/Rev. 1 • €18.00**

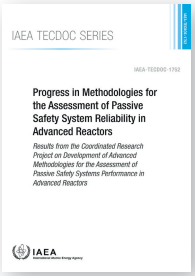


Procurement Engineering and Supply Chain Guidelines in Support of Operation and Maintenance of Nuclear Facilities

IAEA Nuclear Energy Series No. NP-T-3.21

Procurement must be effectively managed to ensure availability of design functions throughout a nuclear facility's service life. Ineffective control of procurement process can jeopardize facility safety, reduce reliability, or can result in increased costs to operating organizations. This publication provides an overview of nuclear procurement processes, issues of special concern, and provides guidance for good practices to set up and manage a high-quality procurement organization. Lessons learned for organizations considering new build nuclear projects are also included.

**(252 pp., 68 figs; 2016) • ISBN 978-92-0-107315-0 •
STI/PUB/1725 • €56.00**



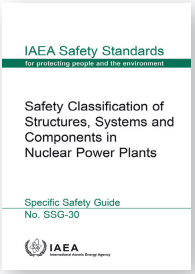
Progress in Methodologies for the Assessment of Passive Safety System Reliability in Advanced Reactors

Results from the Coordinated Research Project on Development of Advanced Methodologies for the Assessment of Passive Safety Systems Performance in Advanced Reactors

IAEA TECDOC Series No. 1752

This publication summarizes the results of an IAEA coordinated research project on the development of advanced methodologies for the assessment of passive safety system performance in advanced reactors. It includes discussions on various methodologies to assess the performance of passive engineered safety features in innovative small reactors, including the Indian AHWR 300 LEU and the Argentinian CAREM25. The publication focuses on the different reliability assessment approaches, methodologies, analysis and evaluation of the results and technical challenges. It provides the insights resulting from the analysis on the technical issues associated with assessing the reliability of passive systems in the context of nuclear safety and probabilistic safety analysis. A viable path towards the implementation of the research efforts in the related areas is also delineated.

(2014) • ISBN 978-92-0-108614-3 • IAEA-TECDOC-1752 • €18.00



Safety Classification of Structures, Systems and Components in Nuclear Power Plants

Specific Safety Guide

IAEA Safety Standards Series No. SSG-30

This Safety Guide provides recommendations and guidance on how to meet the

requirements established in Specific Safety Requirements No. SSR-2/1 and in General Safety Requirements No. GSR Part 4 for the identification of structures, systems and components (SSCs) important to safety in nuclear power plants and for their classification on the basis of their function and safety significance. This Safety Guide is intended primarily for use by organizations involved in the design of nuclear power plants, as well as by regulatory bodies and their technical support organizations. The Safety Guide can also be applied to other nuclear installations subject to appropriate adjustments relevant to the specific design of the type of the facility being considered.

(24 pp., 2 figs; 2014) • ISBN 978-92-0-115413-2 • STI/PUB/1639 • €22.00

Safety of Nuclear Power Plants: Commissioning and Operation

Specific Safety Requirements

IAEA Safety Standards Series No. SSR-2/2 (Rev. 1)

This publication is a revision of IAEA Safety Standards Series No. NS-R-2, Safety of Nuclear Power Plants: Operation, and has been extended to cover the commissioning stage. It describes the requirements to be met to ensure the safe commissioning, operation, and transition from operation to decommissioning of nuclear power plants. Over recent years there have been developments in areas such as long term operation of nuclear power plants, plant ageing, periodic safety review, probabilistic safety analysis review and risk informed decision making processes. It became necessary to revise the IAEA's Safety Requirements in these areas and to correct and/or improve the publication on the basis of feedback from its application by both the IAEA and its Member States. In addition, the requirements are governed by, and must apply, the safety objective and safety principles that are established in the IAEA Safety Standards Series No. SF-1, Fundamental Safety

Principles. A review of Safety Requirements publications, initiated in 2011 following the accident in the Fukushima Daiichi nuclear power plant in Japan, revealed no significant areas of weakness but resulted in a small set of amendments to strengthen the requirements and facilitate their implementation. These are contained in the present publication.

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Safety of Nuclear Power Plants: Design

Specific Safety Requirements

IAEA Safety Standards Series No. SSR-2/1 (Rev. 1)

This publication establishes requirements applicable to the design of nuclear power plants and elaborates on the safety objective, safety principles and concepts that provide the basis for deriving the safety requirements that must be met for the design of a nuclear power plant. It will be useful for organizations involved in design, manufacture, construction, modification, maintenance, operation and decommissioning of nuclear power plants, as well as for regulatory bodies. A review of Safety Requirements publications was commenced in 2011 following the accident in the Fukushima Daiichi nuclear power plant in Japan. The review revealed no significant areas of weakness and resulted in just a small set of amendments to strengthen the requirements and facilitate their implementation, which are contained in the present publication.

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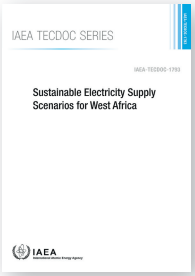

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IAEA TECDOC Series No. 1793

This publication covers topics relevant to Member States in the process of evaluation of future electricity supply options and strategies, from resource evaluation to electricity demand analysis and connections to overall social, economic and demographic developments. It is an outcome of a study carried out in West Africa, providing a coherent sub regional platform for the development of a robust policy framework for an enhanced and sustainable provision of electricity services to support socio economic growth.

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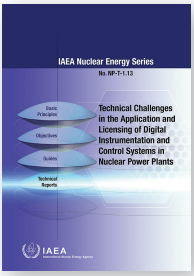

Technical Challenges in the Application and Licensing of Digital Instrumentation and Control Systems in Nuclear Power Plants

IAEA Nuclear Energy Series No. NP-T-1.13

With the modernization of existing analogue instrumentation and control (I&C) systems in nuclear power plants through digital I&C technology, and the implementation of digital I&C systems in new plants, the industry is faced with significant challenges. These challenges appear in the form of difficulties in managing the necessarily incremental transition, highly integrated (and interdependent) architectures, the flexible configurability enabled by digital technology, and uncertainty and inconsistency in licensing digital I&C systems and equipment in the different Member States. This publication discusses 17 major issues that utilities,

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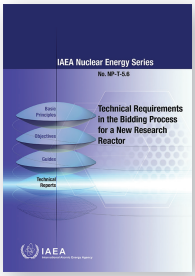

Technical Requirements in the Bidding Process for a New Research Reactor

IAEA Nuclear Energy Series No. NP-T-5.6

Interest in developing research reactor programmes has grown significantly in recent years. Currently, a significant number of Member States are in different stages of new research reactor projects. The majority of them are building their first research reactor as a key national installation for the development of their nuclear science and technology programmes. In this context, this publication has been developed to assist Member States in the preparation of the technical requirements for the bidding process for a new research reactor. The publication addresses the preparation phase of the bidding process and discusses criteria that may be used in the evaluation of the bids. The guidance applies to all reactor types and technologies and it does not recommend a specific reactor type or technology or a specific design. However, it is assumed that the publication will be used by a Member State that has made a commitment to build a safe, sustainable, robust design and easily maintainable research reactor. The guidance provided in the publication is primarily oriented to Member States building their first research reactor; however, such guidance could also be useful for the bidding process for subsequent reactors.

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Third International Conference on Nuclear Power Plant Life Management

Proceedings of an International Conference Held in Salt Lake City, USA, 14–18 May 2012

Proceedings Series

There is a current trend for the operational life of nuclear power plants to be extended beyond that of their original licence period. This publication is the proceedings of the third International Conference on Nuclear Power Plant Life Management, which demonstrated the value of an open exchange of information between experts from different countries and organizations. The presentations cover a wide range of subjects including: very specific solutions for reactor pressure vessel integrity; material degradation; ageing management and licensing renewal approaches; risk informed inspection; non-destructive examination methods; and tools to be used in various stages of plant life management programmes. The publication provides utilities, operators and regulators with a comprehensive state of the science and technology overview of the main issues concerning nuclear power plant life management.

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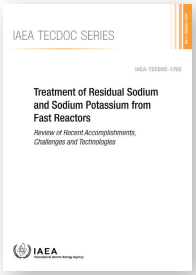

Treatment of Residual Sodium and Sodium Potassium from Fast Reactors

Review of Recent Accomplishments, Challenges and Technologies

IAEA TECDOC Series No. 1769

This publication covers a range of topics related to removal of residual radioactive sodium and sodium potassium coolant from reactor vessels and components in connection with decommissioning of liquid metal cooled reactors. The testing and application of relevant key technologies in five countries at a number of facilities are described.

The technologies include passivation of the residuals, methods to control and monitor the processes, and also gaining access to locations that are difficult to reach and where residual sodium may be found. Non-radioactive sodium waste is not specifically considered in this publication. However, the approach, procedures, and recommendations that apply to safe management of radioactive sodium waste are also largely applicable to non-radioactive sodium. In addition to the technical topics, lessons learned for management of removal and disposal of residual sodium and sodium potassium are also presented.

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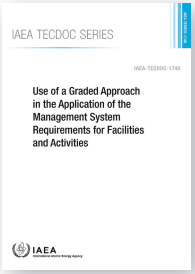

Use of a Graded Approach in the Application of the Management System Requirements for Facilities and Activities

IAEA TECDOC Series No. 1740

In general, a graded approach means a structured method by which the stringency of control to be applied to a product or process is commensurate with the risk associated with a loss of control. This publication presents an overview of grading fundamentals, the grading process, the role of classification in the process and the typical controls that can be graded. It provides practical guidance and examples of grading as required by IAEA Safety Standards Series No. GS-R-3 to develop and apply a method of grading appropriate to the organization. The information provided will be beneficial to users who are in the process of implementing or improving their current management system based on the IAEA safety requirements.

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