



NUCLEAR ENERGY SERIES



IAEA

International Atomic Energy Agency

NUCLEAR ENERGY SERIES

This is an overview of
IAEA Nuclear Energy Series
publications published since 2018
and forthcoming in 2021.

The IAEA serves as the world's intergovernmental forum for scientific and technical cooperation in the nuclear field.

The IAEA is one of the leading publishers in the area, with titles on nuclear and radiological safety, emergency response, nuclear power, nuclear medicine, nuclear waste management, nuclear law and safeguards, as well as relevant topics in food and agriculture, earth science, industry and the environment.

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IAEA Nuclear Energy Series Publications

Structure of the IAEA Nuclear Energy Series

Under the terms of Articles III.A.3 and VIII.C of its Statute, the IAEA is authorized to “foster the exchange of scientific and technical information on the peaceful uses of atomic energy”. The publications in the **IAEA Nuclear Energy Series** present good practices and advances in technology, as well as practical examples and experience in the areas of nuclear reactors, the nuclear fuel cycle, radioactive waste management and decommissioning, and on general issues relevant to nuclear energy. The structure of the **IAEA Nuclear Energy Series** is structured into four levels:

1) The **Nuclear Energy Basic Principles** publication describes the rationale and vision for the peaceful uses of nuclear energy.

2) **Nuclear Energy Series Objectives** publications describe what needs to be considered and the specific goals to be achieved in the subject areas at different stages of implementation.

3) **Nuclear Energy Series Guides and Methodologies** provide high level guidance or methods on how to achieve the objectives related to the various topics and areas involving the peaceful uses of nuclear energy.

4) **Nuclear Energy Series Technical Reports** provide additional, more detailed information on activities relating to topics explored in the **IAEA Nuclear Energy Series**.

The IAEA Nuclear Energy Series publications are coded as follows: **NG** – nuclear energy general; **NR** – nuclear reactors (formerly **NP** – nuclear power); **NF** – nuclear fuel cycle; **NW** – radioactive waste management and decommissioning. In addition, the publications are available in English on the IAEA Internet site:

www.iaea.org/publications

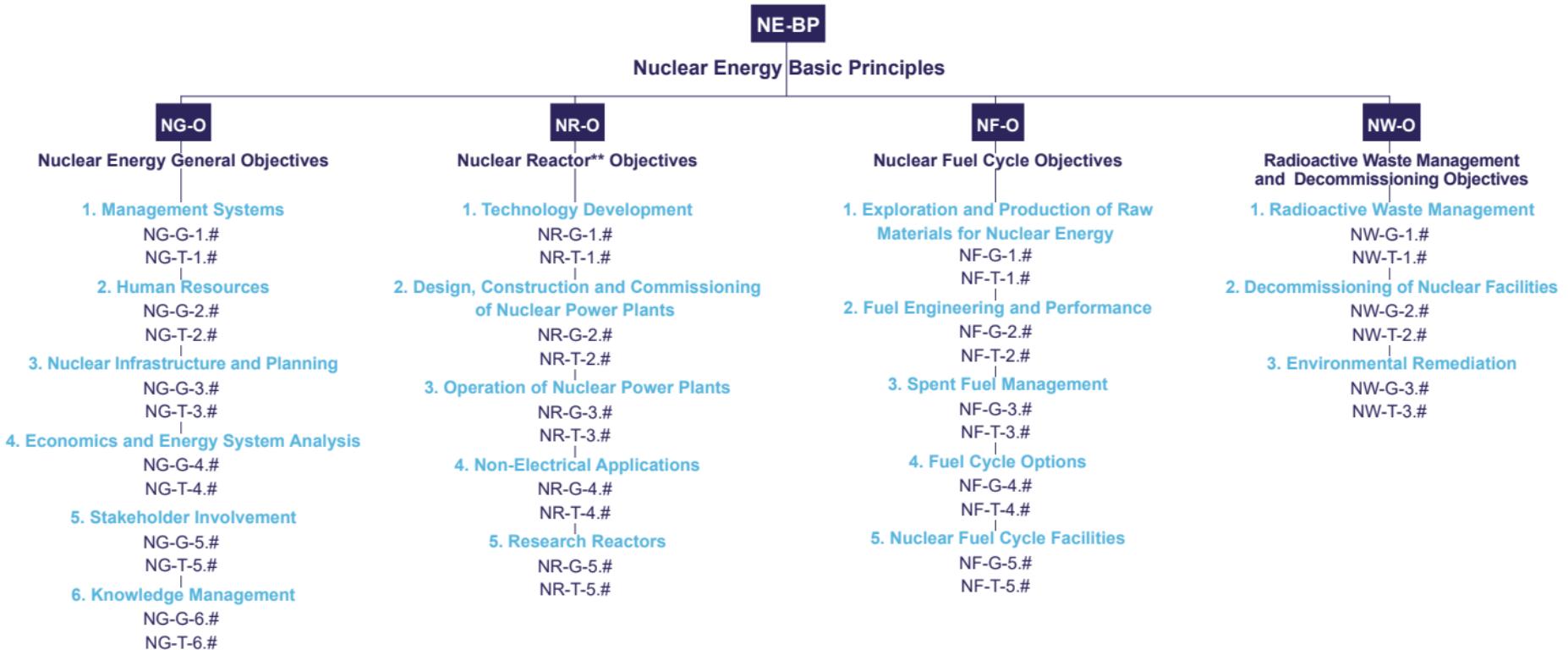
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Structure of the IAEA Nuclear Energy Series*



Topics: NG – Nuclear Energy General; NR – Nuclear Reactors; NF – Nuclear Fuel Cycle; NW – Radioactive Waste Management and Decommissioning

Types: BP – Basic Principles; O – Objectives; G – Guides; T – Technical Reports

* as of 1 January 2020 ** formerly 'Nuclear Power' (NP)

NG-T	11	Nuclear Energy General
NP-T	25	Nuclear Reactors
NF-T	47	Nuclear Fuel Cycle
NW-T	57	Radioactive Waste Management and Decommissioning

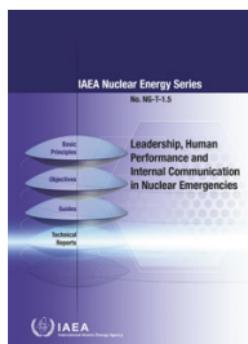


- NG-T 12** Leadership, Human Performance and Internal Communication in Nuclear Emergencies
IAEA Nuclear Energy Series No. NG-T-1.5
- NG-T 13** Management of Nuclear Power Plant Projects
IAEA Nuclear Energy Series No. NG-T-1.6
- NG-T 14** Initiating Nuclear Power Programmes: Responsibilities and Capabilities of Owners and Operators
IAEA Nuclear Energy Series No. NG-T-3.1 (Rev.1)
- NG-T 15** Responsibilities and Functions of a Nuclear Energy Programme Implementing Organization
IAEA Nuclear Energy Series No. NG-T-3.6 (Rev. 1)
- NG-T 16** Strategic Environmental Assessment for Nuclear Power Programmes: Guidelines
IAEA Nuclear Energy Series No. NG-T-3.17
- NG-T 18** Feasibility Study Preparation for New Research Reactor Programmes
IAEA Nuclear Energy Series No. NG-T-3.18
- NG-T 19** Application of Multi-criteria Decision Analysis Methods to Comparative Evaluation of Nuclear Energy System Options:
Final Report of the INPRO Collaborative Project KIND
IAEA Nuclear Energy Series No. NG-T-3.20
- NG-T 21** International Nuclear Management Academy (INMA)
Master's Programmes in Nuclear Technology Management
IAEA Nuclear Energy Series No. NG-T-6.12
- NG-T 22** Mapping Organizational Competencies in Nuclear Organizations
IAEA Nuclear Energy Series No. NG-T-6.14
- NG-T 23** Exploring Semantic Technologies and their Application to Nuclear Knowledge Management
IAEA Nuclear Energy Series No. NG-T-6.15



Nuclear Energy General

Technical Reports



**Leadership, Human
Performance
and Internal
Communication in
Nuclear Emergencies**
IAEA Nuclear Energy
Series No. NG-T-1.5

(36 pp., 2 figs; 2018)
ISBN 978-92-0-103317-8
STI/PUB/1789 • €30.00

This publication focuses on the challenges and their possible solutions in the areas of leadership, human performance and internal communication in a severe nuclear emergency. It presents a brief overview of some of the key concepts, especially how they relate to an organization's ability to successfully manage an emergency event. The target audience for this publication are those officials and senior managers dealing with emergency response in the operating organization, government, local authorities and the regulatory body. Those who have an influence on the style of leadership and personnel development and training that is applied in their organizations and who are involved in emergency preparedness and response will also benefit from this publication.

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Management of Nuclear Power Plant Projects

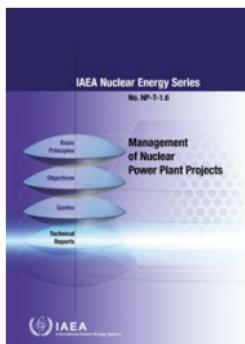
IAEA Nuclear Energy

Series No. NG-T-1.6

(160 pp., 5 figs; 2020)

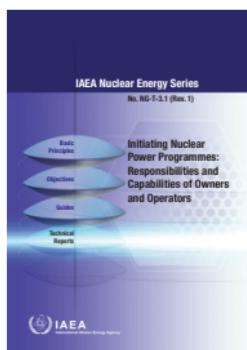
ISBN 978-92-0-104719-9

STI/PUB/1868 • €55.00



Member States intending to introduce a nuclear power programme in their country will need to pass through several phases during the implementation. Experience shows that careful planning of the objectives, roles, responsibilities, interfaces and tasks to be carried out in different phases of a nuclear project is important for success. This publication presents a harmonized approach that may be used to structure the owner/operator management system and establish and manage nuclear projects and their development activities irrespective of the adopted approach. It has been developed from shared management practices and consolidated experiences provided by nuclear project management specialists through a series of workshops and working groups organized by the IAEA. The resultant publication presents a useful framework for the management of nuclear projects from initiation to closeout and captures international best practices.

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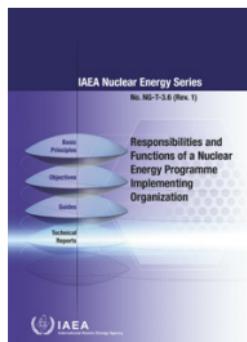
Initiating Nuclear Power Programmes: Responsibilities and Capabilities of Owners and Operators

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

(31 pp., 8 figs; 2020)
ISBN 978-92-0-104619-2
STI/PUB/1867 • €30.00

The development of the infrastructure for a nuclear power programme includes the establishment of policies and strategies in areas such as human resource development, nuclear fuel cycle and waste management, industrial involvement and nuclear safety. It also requires the establishment of a legal and regulatory framework that creates an environment enabling the project to be implemented in a transparent and effective manner. These elements of this infrastructure will have an impact on the project and will guide the discussions of the future owner/operator with potential vendors. In this regard, it is important that the owner/operator, if already identified, participates in this process from the beginning. This publication provides guidance on the establishment and development of the owner/operator so that it can discharge its responsibilities throughout the phases of the programme. It also discusses the management of the interfaces between the owner/operator and other stakeholders.

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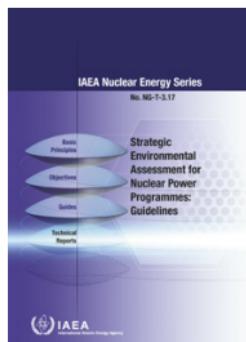
Responsibilities and Functions of a Nuclear Energy Programme Implementing Organization

**IAEA Nuclear Energy
Series No. NG-T-3.6
(Rev. 1)**

(44 pp., 17 figs; 2019)
ISBN 978-92-0-100619-6
STI/PUB/1845 • €36.00

An important element of the milestones approach to introducing nuclear power is a mechanism to coordinate efforts among the many organizations and individuals who have roles to play in the process. This mechanism is referred to as a nuclear energy programme implementing organization (NEPIO). This publication describes a set of responsibilities, functions and activities that States can use as guidance for establishing a NEPIO and ensuring its effectiveness. This revision incorporates lessons learned from integrated nuclear infrastructure review missions and IAEA technical assistance activities. It attempts to clarify that there are many ways to structure a NEPIO and that each could result in the successful execution of all functions and activities. Several case studies are included. Consistent with the revision of IAEA Nuclear Energy Series No. NG-G-3.1 (Rev. 1) Milestones in the Development of a National Infrastructure for Nuclear Power published in 2015, this publication recognizes that the NEPIO plays an important and evolving role in each of the three phases of nuclear power infrastructure development.

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Strategic Environmental Assessment for Nuclear Power Programmes: Guidelines

**IAEA Nuclear Energy
Series No. NG-T-3.17**

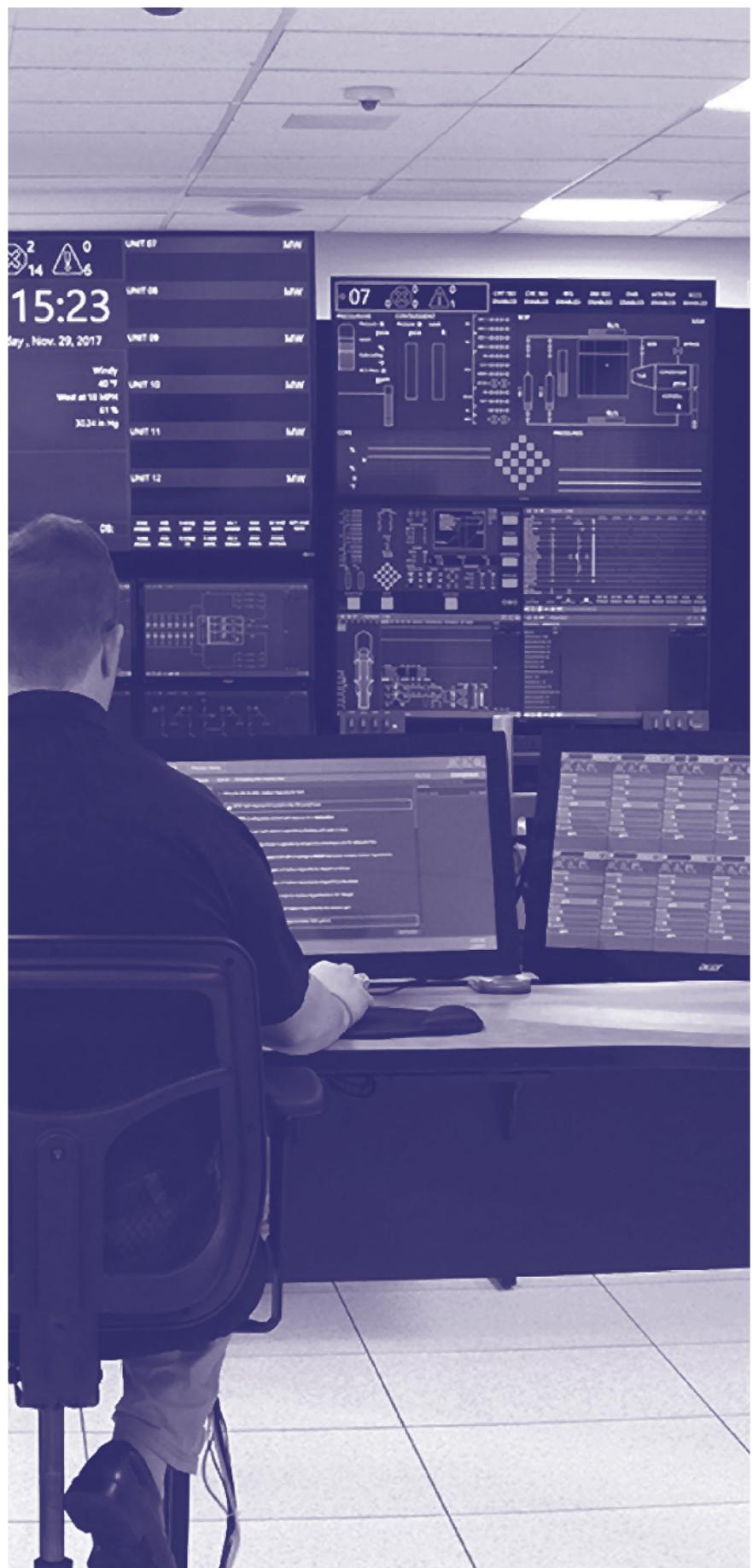
(74 pp., 17 figs; 2018)

ISBN 978-92-0-104418-1

STI/PUB/1815 • €36.00

This publication provides practical guidance for performing strategic environmental assessments (SEAs) for nuclear power programmes. It incorporates the latest knowledge and draws on best practices in conducting SEAs. Based on inputs from SEA experts from across the world, it lays down an effective SEA process that contributes to: strengthening decision making for nuclear power programmes; achieving environmentally sound and sustainable development; and improving good governance and building public trust and confidence in decision-making. Importantly, SEA for nuclear power programmes can ensure effective communication with the public and other stakeholders. Consequently, significant emphasis is placed on stakeholder engagement and public participation. Further, appropriate tools for assessment and quality review are presented for all stages of the SEA process.

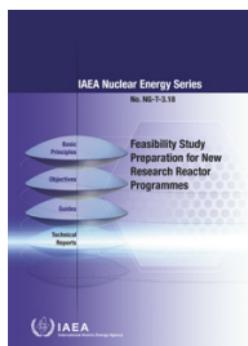
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Feasibility Study Preparation for New Research Reactor Programmes

IAEA Nuclear Energy

Series No. NG-T-3.18



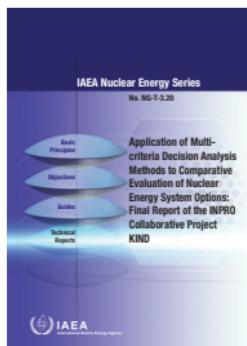
(33 pp., 5 figs; 2018)

ISBN 978-92-0-104518-8

STI/PUB/1816 • €30.00

This publication describes the various elements to be included in a comprehensive, robust and logically structured feasibility study report for a new research reactor project. It provides guidance for the main supporting organization or team of a new research reactor to enable them to undertake an authoritative and comprehensive feasibility study that could be submitted to decision makers for their review in order to support proposals and endorse an action plan for construction of such a facility. It includes considerations of justification for a new research reactor, associated key nuclear infrastructure issues, cost-benefit analysis and risk management that would have to be addressed prior to authorizations for the establishment of a new research reactor. Addressing these issues will help Member States to develop a comprehensive understanding of all the roles, obligations and commitments involved in establishing and operating a research reactor and ensure that these are met during all phases of the project life cycle. The publication also includes a generic template for preparing a feasibility study report and provides some examples and lessons learned from individual Member States in preparing such studies.

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Application of Multi-criteria Decision Analysis Methods to Comparative Evaluation of Nuclear Energy System Options: Final Report of the INPRO Collaboration Project KIND

**IAEA Nuclear Energy
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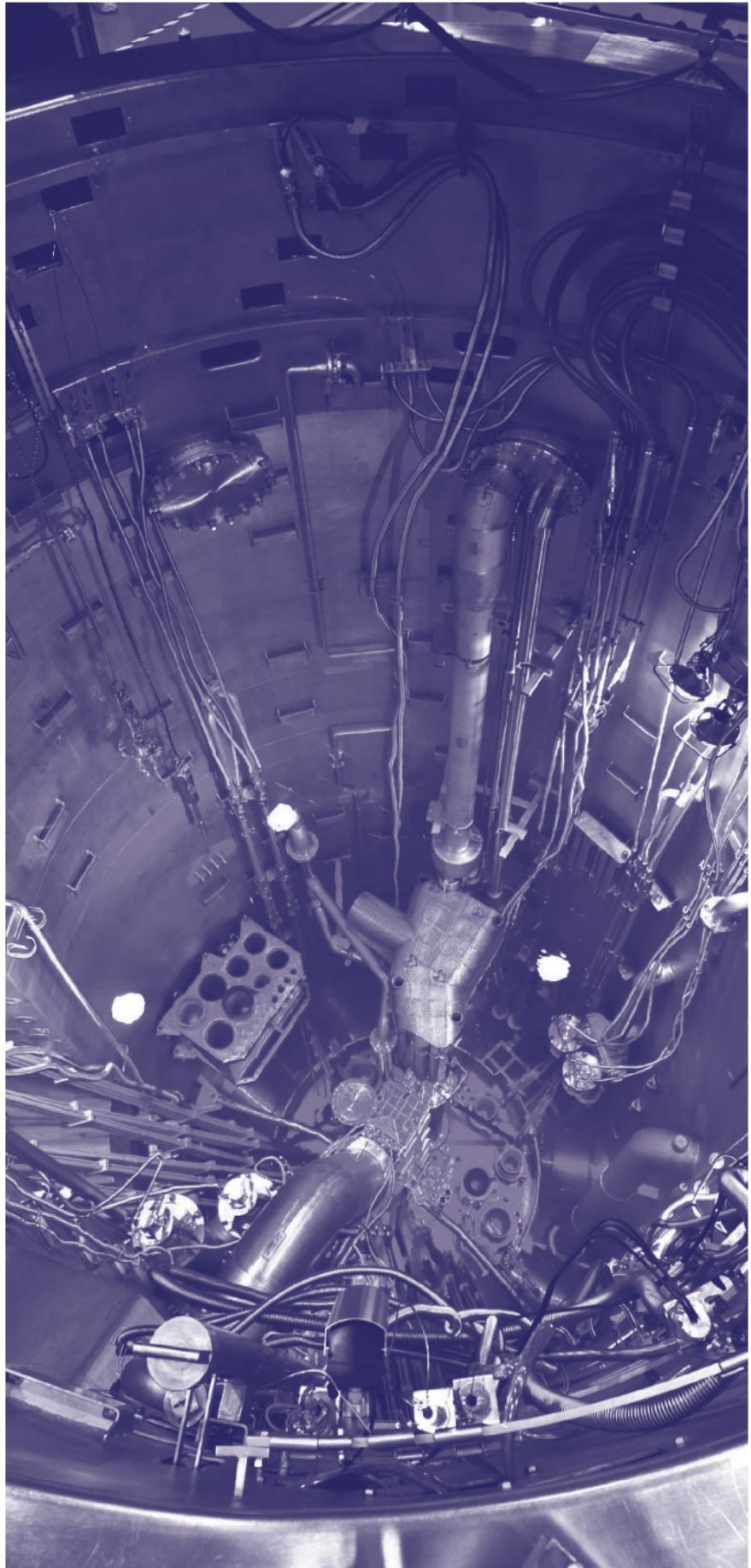
(229 pp., 162 figs; 2019)

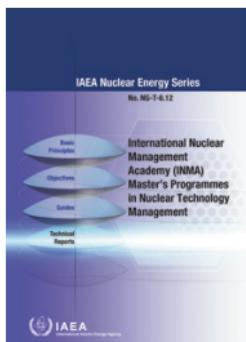
ISBN 978-92-0-102319-3

STI/PUB/1853 • €58.00

This publication presents the results of a collaborative project on key indicators for innovative nuclear energy systems. It describes the approach and several case studies performed by Member States to evaluate, on a comparative basis, both nuclear energy system and nuclear energy evolution scenario options with evolutionary and innovative nuclear energy technologies and examines the applicability of this approach for different kinds of problems in the nuclear and non-nuclear energy planning fields.

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International Nuclear Management Academy (INMA) Master's Programmes in Nuclear Technology Management

IAEA Nuclear Energy

Series No. NG-T-6.12

(94 pp., 4 figs; 2020)

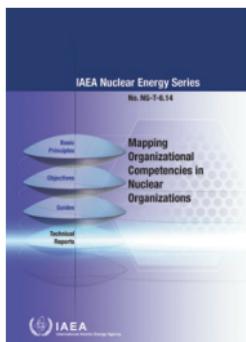
ISBN 978-92-0-107217-7

STI/PUB/1795 • €38.00

The IAEA facilitated International Nuclear Management Academy (INMA) supports universities to establish and deliver master's degree programmes focusing on technology management for the nuclear sector including nuclear power programmes, nuclear applications and radiological technologies. The current publication provides guidance for these master's programmes that have a specialized focus on the advanced aspects of management and leadership required by the nuclear sector. It describes the requirements for an INMA nuclear technology management programme (NTM) as well as recommendations for their implementation. The process for a university's NTM programme to be endorsed by the IAEA, including peer review missions, is described in detail with templates for the required information package included. The publication is applicable to universities, stakeholders of nuclear educational programmes and any other nuclear or radiological organization wishing to support the education of their managers and leaders.

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Forthcoming



Mapping Organizational Competencies in Nuclear Organizations

IAEA Nuclear Energy

Series No. NG-T-6.14

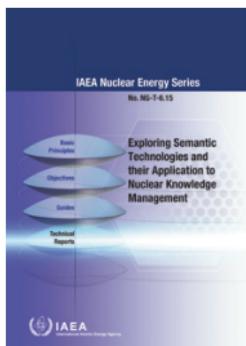
ISBN 978-92-0-100519-9

STI/PUB/1844 • €32.00

This publication outlines the concepts and models supporting the requirements for understanding organizational competence within the nuclear context. It aims to help in the development of organizational competencies in both countries with an existing nuclear power capability and those wishing to embark on a nuclear power programme for the first time. The publication summarizes necessary processes for mapping organizational competencies, as well as tools and techniques used for assessing them. Specific guidance provided in this publication will help organizations to determine competence needs based on strategic/corporate objectives and business processes and to identify their existing success factors.

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Forthcoming



Exploring Semantic Technologies and their Application to Nuclear Knowledge Management

**IAEA Nuclear Energy
Series No. NG-T-6.15**

ISBN 978-92-0-108719-5

STI/PUB/1899 • €36.00

Within the nuclear field, a vast body of knowledge, involving scientific, technical and managerial fields is distributed among many organizations of different types. Managing and provisioning distributed knowledge is therefore becoming one of the major challenges in federated organizational environments. This publication provides guidance to organizations dealing with nuclear knowledge and its management. It covers an introduction to semantic information technologies, the Worldwide Web standards developed for interoperability, the construction of knowledge bases relying on distributed knowledge, and the development of knowledge driven applications. In addition to providing insight into the development of distributed knowledge bases, the intent of this publication is to provide examples of applications of semantic technologies specifically in the nuclear field.

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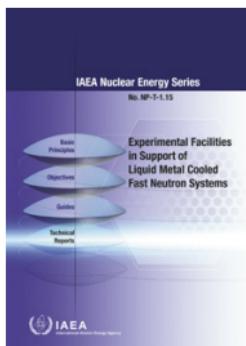
NP-T	26	Experimental Facilities in Support of Liquid Metal Cooled Fast Neutron Systems IAEA Nuclear Energy Series No. NP-T-1.15
NP-T	27	Guidance on Nuclear Energy Cogeneration IAEA Nuclear Energy Series No. NP-T-1.17
NP-T	28	Commissioning Guidelines for Nuclear Power Plants IAEA Nuclear Energy Series No. NP-T-2.10
NP-T	30	Approaches for Overall Instrumentation and Control Architectures of Nuclear Power Plants IAEA Nuclear Energy Series No. NP-T-2.11
NP-T	31	Industrial Safety Guidelines for Nuclear Facilities IAEA Nuclear Energy Series No. NP-T-3.3
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NR-T	45	Specific Considerations in the Assessment of the Status of the National Nuclear Infrastructure for a New Research Reactor Programme IAEA Nuclear Energy Series No. NR-T-5.9

A large, dark, ribbed industrial steam turbine or compressor sits prominently in the background of a factory or workshop. In the foreground, two workers wearing white protective suits, hard hats, and safety glasses are looking down at a large sheet of paper or blueprint spread out on a workbench. They appear to be discussing it. The environment is filled with various industrial equipment, pipes, and structural elements.

Nuclear Reactors

Technical Reports
Guides

Experimental Facilities in Support of Liquid Metal Cooled Fast Neutron Systems



IAEA Nuclear Energy

Series No. NP-T-1.15

(52 pp., 2018)

ISBN 978-92-0-101018-6

STI/PUB/1806 • €30.00

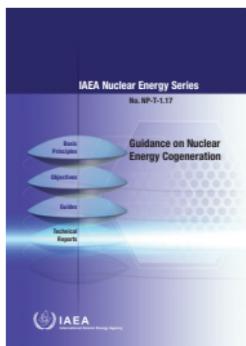
This publication presents both an overview and detailed information on more than 150 experimental facilities being used for developing and deploying innovative liquid metal-cooled (sodium, lead and lead-bismuth) fast neutron systems, both critical and subcritical. Facilities, both under construction and those in operation are considered. It is expected that by providing the end users with detailed information on existing and future experimental facilities able to support innovative liquid metal cooled fast neutron systems, the publication will facilitate cooperation between organizations and knowledge transfer. An overview of the existing and future experimental facilities is presented in the body text of this publication. The profiles of all facilities in the form of individual papers are available on the attached CD-ROM and in the related on-line database maintained by the IAEA Catalogue of Facilities in Support of Liquid Metal Cooled Fast Neutron Systems (LMFNS Catalogue).

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Guidance on Nuclear Energy Cogeneration

IAEA Nuclear Energy

Series No. NP-T-1.17



(52 pp., 17 figs; 2019)

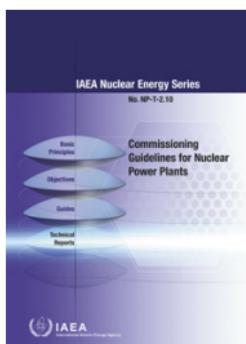
ISBN 978-92-0-104119-7

STI/PUB/1862 • €32.00

Cogeneration, i.e. the production of electricity and heat, has proven to be a highly efficient and environmentally attractive option for energy conversion. Nuclear cogeneration could be considered as an option in light of actions on climate change. However, nuclear cogeneration is not widely deployed. This publication provides a quick introduction to the advantages, experience, and future planning for implementation of nuclear cogeneration. It also highlights some demonstration projects that were developed in the past in connection with industries, describing technical concepts for combined nuclear-industrial complexes. The publication is intended to be of interest to users in academia and industry as well as government agencies and public institutions requiring basic information on various aspects of using nuclear power for cogeneration.

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Commissioning Guidelines for Nuclear Power Plants



IAEA Nuclear Energy

Series No. NP-T-2.10

(133 pp., 31 figs; 2018)

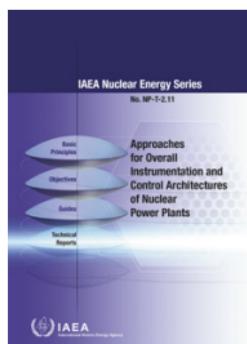
ISBN 978-92-0-102816-7

STI/PUB/1742 • €48.00

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 in 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.

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Approaches for Overall Instrumentation and Control Architectures of Nuclear Power Plants

**IAEA Nuclear Energy
Series No. NP-T-2.11**

(55 pp., 9 figs; 2018)

ISBN 978-92-0-102718-4

STI/PUB/1821 • €30.00

This publication concerns approaches for establishing the overall instrumentation and control (I&C) architecture of a nuclear power plant. It describes the characteristics and content of general I&C architectures, presents architectural principles and addresses the limitation of the potential effects of postulated common cause failures. It introduces an architectural development process and discusses technical considerations for the design. The publication emphasizes safety aspects, addresses the defence in depth concept, but also includes consideration of plant availability, operability and security. It recognizes the potential for adverse effects of I&C failures on plant availability and operability that may arise from increased architectural complexity, and also describes the optimization of I&C functionality and features that are required to be implemented.

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Industrial Safety Guidelines for Nuclear Facilities

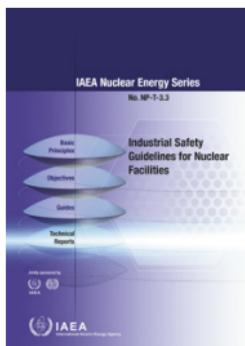
IAEA Nuclear Energy

Series No. NP-T-3.3

(244 pp., 87 figs; 2018)

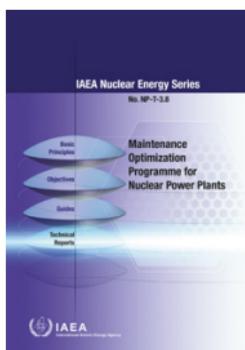
ISBN 978-92-0-101617-1

STI/PUB/1774 • €60.00



These IAEA guidelines on industrial safety for nuclear facilities are co-sponsored by the International Labour Organization. Specific review of industrial safety practices at nuclear plants have been part of the IAEA OSART (Operational Safety Review Team) missions for decades, and supplementary guidance for such reviews has been available since 1990. This publication presents the latest good practices that nuclear organizations have put into place to implement high quality industrial safety programmes.

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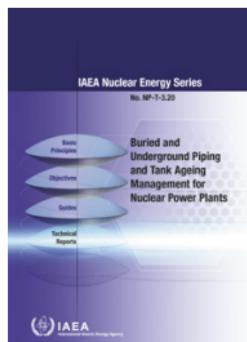
Maintenance Optimization Programme for Nuclear Power Plants

**IAEA Nuclear Energy
Series No. NP-T-3.8**

(48 pp., 8 figs; 2018)
ISBN 978-92-0-110916-3
STI/PUB/1757 • €39.00

This publication deals with the latest nuclear power plant maintenance optimization programmes and provides key requirements and strategies for successful implementation. Details of maintenance processes, prerequisites of and approaches to maintenance optimization, and performance monitoring are provided. The publication documents shared proven maintenance optimization methods and techniques from Member States, including more detailed examples in the annexes of this publication.

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

**IAEA Nuclear Energy
Series No. NP-T-3.20**

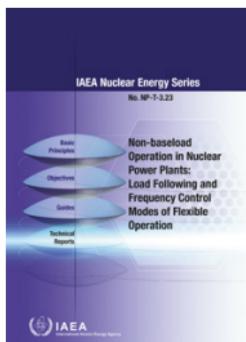
(377 pp., 227 figs; 2018)

ISBN 978-92-0-102116-8

STI/PUB/1735 • €60.00

This publication is one in a series of reports on the assessment and management of ageing of the major nuclear power plant components. It deals with buried and underground piping and tank systems that are included as part of a nuclear power plant 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 nuclear power plant owners, operators, designers, engineers and specialists.

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Non-baselload Operation in Nuclear Power Plants: Load Following and Frequency Control Modes of Flexible Operation

IAEA Nuclear Energy

Series No. NP-T-3.23

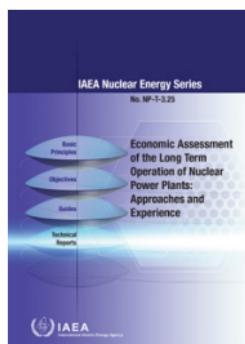
(173 pp., 62 figs; 2018)

ISBN 978-92-0-110816-6

STI/PUB/1756 • €40.00

This publication aims to address all relevant aspects of flexible (non-baselload) operation of nuclear power plants specifically focusing on changing electrical output to match the electrical demand and to control the frequency of the electrical system. It provides collective guidance based on current knowledge and operational experience, for the decision making, preparation and implementation of flexible operation for Member States who are considering future flexible operations of their nuclear power plants.

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Economic Assessment of the Long Term Operation of Nuclear Power Plants: Approaches and Experience

**IAEA Nuclear Energy
Series No. NP-T-3.25**

(126 pp., 27 figs; 2018)

ISBN 978-92-0-104218-7

STI/PUB/1813 • €47.00

This publication describes the various approaches to the techno-economic assessment of a project for the long term operation of a nuclear power plant in its specific market environment. It examines the process of defining the technical scope required to prolong the operating licences of nuclear power plants and highlights the need for further studies on technical cost drivers and economic assessments in order to better define the cost boundaries of long term operation. Information is also provided on the new IAEA software LTOFIN, which was developed to assist in performing long term operation economic assessments within the process described in the publication.

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Managing Counterfeit and Fraudulent Items in the Nuclear Industry

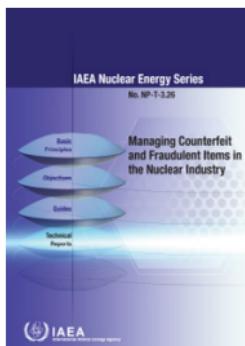
IAEA Nuclear Energy

Series No. NP-T-3.26

(94 pp., 25 figs; 2019)

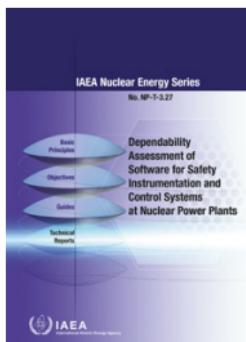
ISBN 978-92-0-102318-6

STI/PUB/1817 • €39.00



Counterfeit and fraudulent items (CFIs) are of increasing concern in the nuclear industry and generally throughout the industrial and commercial supply chains. Experience has shown that a lack of control of the processes involved in the sourcing, receipt, use and/or disposal of items can lead to the introduction of counterfeit or fraudulent items into a nuclear facility. This publication is designed to assist Member State organizations to prevent, detect and address the issue of CFIs on an ongoing basis. It provides users with recognized good practices for the introduction of a programme to effectively manage CFIs in the nuclear industry.

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Dependability Assessment of Software for Safety Instrumentation and Control Systems at Nuclear Power Plants

IAEA Nuclear Energy

Series No. NP-T-3.27

(80 pp., 10 figs; 2018)

ISBN 978-92-0-101218-0

STI/PUB/1808 • €38.00

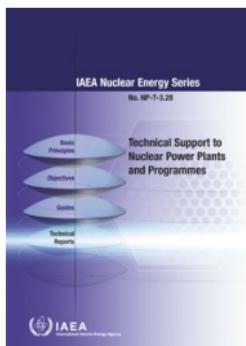
This publication defines a framework that represents the state of the art in assessment methodologies for safety and instrumentation and control software used at nuclear power plants. It describes an approach for developing and communicating assessments based on claims, argument and evidence. The assessment of software dependability, which encompasses properties such as safety, reliability, availability, maintainability and security, is an essential and challenging aspect of the safety justification. Guiding principles for a dependability assessment are established to provide the basis for defining an assessment strategy and implementing the assessment process. Sources of evidence for the assessment are provided and lessons learned from past digital instrumentation and control system implementation in areas such as software development, operational usage, regulatory review and platform certification are also described.

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Technical Support to Nuclear Power Plants and Programmes

IAEA Nuclear Energy

Series No. NP-T-3.28



(130 pp., 20 figs; 2018)

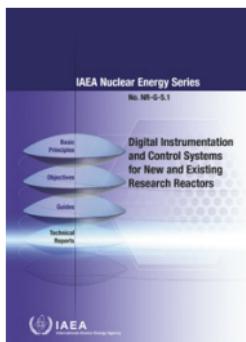
ISBN 978-92-0-103018-4

STI/PUB/1824 • €42.00

This publication addresses relevant aspects of requesting and obtaining effective technical support (TS) and its adequate utilization in decision making on nuclear power programmes, projects and plants. It describes the TS functions and associated organizational activities and skills in providing technical and scientific input to the decisions on plant safety and performance throughout the plant's lifecycle and serves as a guidance for establishing and sustaining TS capability and capacity in Member States both embarking on nuclear power programmes and operating nuclear power plants. The publication also presents observations, lessons learned and conclusions drawn from good practices for defining and maintaining roles, responsibilities and interfacing requirements of technical support organizations (TSOs), nuclear power project/plant entities and other stakeholders. As such, it provides a set of descriptive and practiced processes that integrate technical and scientific information for safety, performance and economical aspects in support of sound and timely decisions on the safe, reliable and efficient operation of nuclear power plants.

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Forthcoming



Digital Instrumentation and Control Systems for New and Existing Research Reactors

**IAEA Nuclear Energy
Series No. NR-G-5.1**

ISBN 978-92-0-118320-0

STI/PUB/1914 • €34.00

IAEA work in the area of research reactor operation and maintenance is aimed at enhancing the capabilities of Member States to utilize good engineering and management practices to improve research reactor reliability and availability. In particular, the IAEA supports activities addressing ageing management of research reactor instrumentation and control (I&C) systems. The purpose of this publication is to provide engineering guidance on the design, and operational aspects of digital I&C systems for the refurbishment of existing facilities and for new research reactors. Key areas addressed include codes and standards applicability, licensing issues, dealing with the change in human-system interface from analogue to digital technology, software verification and validation activities, periodic testing and inspection, and configuration management. The publication contains technical descriptions and summaries of available digital systems that have been utilized in both new research reactor designs, and in the upgrading of older analogue safety and control systems. This guidance is foreseen for the broad spectrum of research reactors types existing today.

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Passive Shutdown Systems for Fast Neutron Reactors

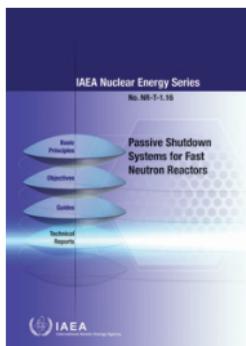
IAEA Nuclear Energy

Series No. NR-T-1.16

(110 pp., 93 figs; 2020)

ISBN 978-92-0-104219-4

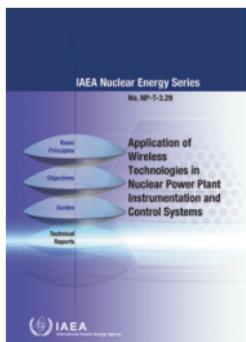
STI/PUB/1863 • €38.00



Designs for nuclear power plants increasingly include passive features. A major focus of the design of modern fast reactors is on inherent and passive safety. Inherent and passive safety features are especially important when active systems such as emergency shutdown systems for reactor shutdown are not functioning properly. This publication discusses the past experience in the development of such systems along with the research that is ongoing. It is a comprehensive publication which provides information on the basic design principles for passive shutdown systems and the related operational experience gathered so far, and also reviews the innovative concepts under development and the needs for research and development and qualification tests.

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Forthcoming



Application of Wireless Technologies in Nuclear Power Plant Instrumentation and Control Systems

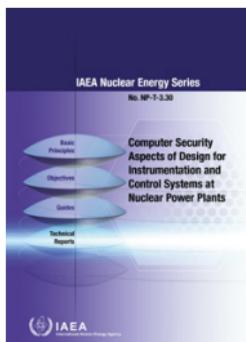
**IAEA Nuclear Energy
Series No. NR-T-3.29**

**ISBN 978-92-0-104819-6
STI/PUB/1869 • €46.00**

This publication summarizes the results of an IAEA coordinated research project on the application of wireless technologies in the nuclear industry. It provides an overview of the current knowledge, existing practices, operating experiences and benefits and challenges related to the use of the technology in instrumentation and control systems of nuclear facilities. The research areas covered were codes, standards and regulatory guides; wireless technologies for nuclear applications; practices, experience, lessons learned; potential wireless applications, and emerging technologies and challenges. The main part of the publication contains guidance derived from the results achieved in each research area. The annexes include supporting information and selected details of the research work that was performed. The information provided in this publication supports Member States' capabilities in the design, development, implementation, operation and, as necessary, licensing of wireless technologies in the nuclear industry.

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Forthcoming



Computer Security Aspects of Design for Instrumentation and Control Systems at Nuclear Power Plants

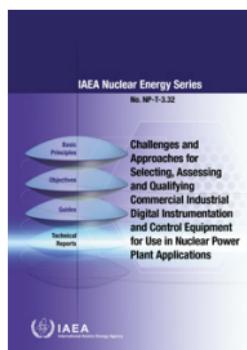
IAEA Nuclear Energy Series No. NR-T-3.30

ISBN 978-92-0-104919-3

STI/PUB/1870 • €35.00

The transition to digital technology has changed the nature of instrumentation and control (I&C) systems by enabling extensive interconnection of reprogrammable, functionally interdependent I&C systems. This development has made computer security a necessary element for consideration in I&C system design. The benefits and challenges of the various computer security methods and controls with their implementation in nuclear power plant I&C systems are discussed and described in this publication. It provides an overview of current knowledge, up to date good practices, experience, and benefits and challenges related to the application of computer security measures. The publication defines the key concepts for computer security for I&C systems at nuclear facilities, explains the risk informed approach to computer security and describes how computer security measures are applied throughout the I&C system life cycle. Situations where I&C systems are interconnected with enterprise management systems are also addressed. The three appendices present case studies with practical application examples.

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Challenges and Approaches for Selecting, Assessing and Qualifying Commercial Industrial Digital Instrumentation and Control Equipment for Use in Nuclear Power Plant Applications

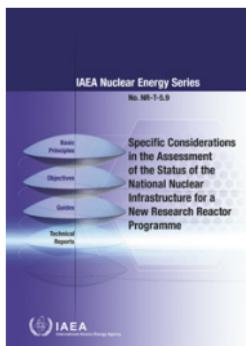
**IAEA Nuclear Energy
Series No. NR-T-3.31**

(81 pp., 7 figs; 2020)
ISBN 978-92-0-105019-9
STI/PUB/1871 • €38.00

The focus of this publication is on the activities required to demonstrate the suitability of commercial off the shelf (COTS) digital instrumentation and control equipment for use in nuclear safety applications. The publication provides a detailed discussion of the typical challenges associated with the use of COTS devices, including issues associated with unique vulnerabilities and features of digital products. It outlines the strategy for digital COTS device assessment and qualification and describes the typical elements of the process. The publication addresses the specific steps of any justification, including identifying the requirements, selection of the supplier and candidate equipment, planning, assessment and identification of equipment life issues, suitability evaluation and all associated documentation. Guidance on maintaining the compliance of COTS devices as well as related regulatory aspects are also covered.

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Forthcoming



Specific Considerations in the Assessment of the Status of the National Nuclear Infrastructure for a New Research Reactor Programme

**IAEA Nuclear Energy
Series No. NR-T-5.9**

**ISBN 978-92-0-112520-0
STI/PUB/1907 • €36.00**

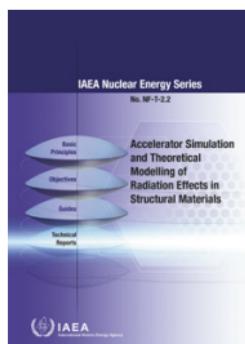
The assessment approach described in this publication provides a comprehensive means to determine the status of the infrastructure conditions relevant to all issues detailed in IAEA Nuclear Energy Series No. NP-T-5.1, Specific Considerations and Milestones for a Research Reactor Project. This approach can be used by any interested Member State for self-assessment to identify weaknesses and to determine the additional work needed to develop its national nuclear infrastructure for research reactor programme to an appropriate level. Member States planning to embark on both a research reactor programme and a nuclear power programme, may refer to this publication to ensure that the approach and methodology for the implementation of both programmes is harmonized, efficient and effective.

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IAEA Nuclear Energy Series No. NF-T-2.2
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IAEA Nuclear Energy Series No. NF-T-2.5
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IAEA Nuclear Energy Series No. NF-T-3.1
- NF-T 52** International Safeguards in the Design of Reprocessing Plants
IAEA Nuclear Energy Series No. NF-T-3.2
- NF-T 53** Storing Spent Fuel until Transport to Reprocessing or Disposal
IAEA Nuclear Energy Series No. NF-T-3.3
- NF-T 54** Enhancing Benefits of Nuclear Energy Technology Innovation through Cooperation among Countries: Final Report of the INPRO Collaborative Project SYNERGIES
IAEA Nuclear Energy Series No. NF-T-4.9
- NF-T 55** International Safeguards in the Design of Enrichment Plants
IAEA Nuclear Energy Series No. NF-T-4.10

Nuclear Fuel Cycle

Technical Reports



Accelerator Simulation and Theoretical Modelling of Radiation Effects in Structural Materials

**IAEA Nuclear Energy
Series No. NF-T-2.2**

(116 pp., 2018)
ISBN 978-92-0-107415-7
STI/PUB/1732 • €39.00

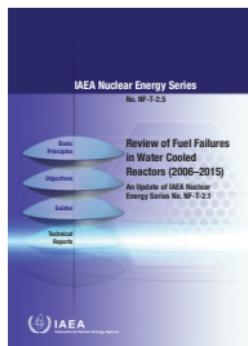
This publication summarizes the findings and conclusions of the IAEA coordinated research project (CRP) on accelerator simulation and theoretical modelling of radiation effects, aimed at supporting Member States in the development of advanced radiation resistant structural materials for implementation in innovative nuclear systems. This aim can be achieved through enhancement of both experimental neutron-emulation capabilities of ion accelerators and improvement of the predictive efficiency of theoretical models and computer codes. This dual approach is challenging but necessary, because outputs of accelerator simulation experiments need adequate theoretical interpretation, and theoretical models and codes need high dose experimental data for their verification. Both ion irradiation investigations and computer modelling have been the specific subjects of the CRP, and the results of these studies are presented in this publication which also includes state of the art reviews of four major aspects of the project: challenges and trends of structural materials development for present and future reactor designs, accelerator methodologies for material testing, multiscale modelling tools, and advanced examination techniques.

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Review of Fuel Failures in Water Cooled Reactors (2006–2015)

IAEA Nuclear Energy

Series No. NF-T-2.5



(65 pp., 22 figs; 2019)

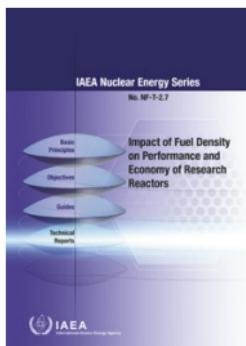
ISBN 978-92-0-104319-1

STI/PUB/1864 • €35.00

Since the 1970's, the IAEA has been involved in the analysis of fuel failures in water cooled reactors in normal (non-accident) operational conditions. This updated version of IAEA Nuclear Energy Series No. NF-T-2.1 provides information on all aspects of such fuel failures in current nuclear power plant operations. It summarizes fuel failure occurrences, their mechanisms and root causes, as well as fuel failure prevention and management in plant operation for 97% of light and heavy water cooled nuclear power units operated worldwide during the period 2006–2015. Data on fuel failures 1987–2006 extracted from three previous IAEA fuel failure reports are included and analysed in the present publication together with the 2006–2015 fuel failure data to reveal long term tendencies in fuel performance. In addition to fuel rod leakers, fuel structural damages and other fuel assembly issues are considered in the report.

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Forthcoming



Impact of Fuel Density on Performance and Economy of Research Reactors

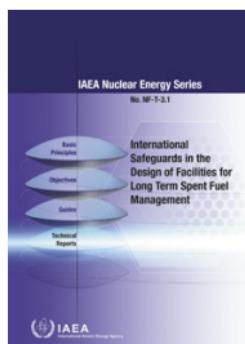
**IAEA Nuclear Energy
Series No. NF-T-2.7**

ISBN 978-92-0-120320-5

STI/PUB/1917 • €35.00

Research reactor fuel technology continues to evolve, driven in part by international efforts to develop high density fuels to enable the conversion of more reactors from highly enriched uranium (HEU) to low enriched uranium (LEU) fuels. These high density fuels may offer economic benefits for research reactors, despite being more expensive initially, because they offer the prospect of higher per-assembly burnup, thus reducing the number of assemblies that must be procured, and more flexibility in terms of spent fuel management compared to the currently qualified and commercially available LEU silicide fuels. Additionally, these new fuels may offer better performance characteristics. This publication provides a preliminary evaluation of the impacts on research reactor performance and fuel costs from using high density fuel. Several case studies are presented and compared to illustrate these impacts.

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International Safeguards in the Design of Facilities for Long Term Spent Fuel Management

**IAEA Nuclear Energy
Series No. NF-T-3.1**

(70 pp., 25 figs; 2018)
ISBN 978-92-0-100717-9 •
STI/PUB/1767 • €36.00

This publication is the fifth in the IAEA Nuclear Energy Series to provide guidance on the inclusion of safeguards in nuclear facility design and construction. It is principally intended for designers and operators of facilities for long term spent fuel management; however, vendors, national authorities and financial backers can also benefit from the information provided. The publication complements the general considerations addressed in International Safeguards in Nuclear Facility Design and Construction, IAEA Nuclear Energy Series No. NP-T-2.8.

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International Safeguards in the Design of Reprocessing Plants

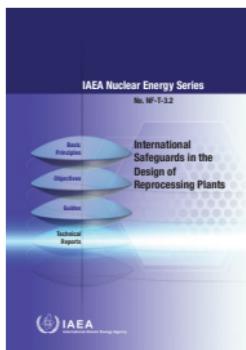
IAEA Nuclear Energy

Series No. NF-T-3.2

(62 pp., 15 figs; 2019)

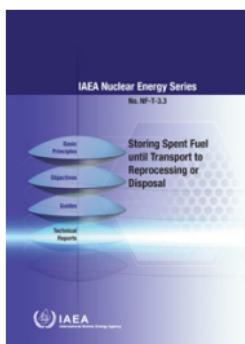
ISBN 978-92-0-104519-5

STI/PUB/1866 • €34.00



This publication is part of a series that aims to inform nuclear facility designers, vendors, operators and State governments, about IAEA safeguards and how associated requirements can be considered early in the design phase of a new nuclear facility. This particular publication is applicable to the design of spent nuclear fuel reprocessing plants. Safeguards by design dialogue undertaken early in the design and construction of reprocessing plants, facilitates the implementation of safeguards throughout all the lifecycle stages of the facility. The potential to reduce costs, avoid retrofits and achieve efficiencies both for the operator and for IAEA Member States, are important drivers for the early consideration of safeguards in a nuclear facility design project.

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Storing Spent Fuel until Transport to Reprocessing or Disposal

IAEA Nuclear Energy

Series No. NF-T-3.3

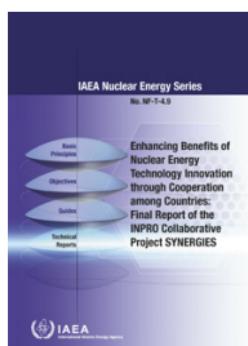
(40 pp., 4 figs; 2019)

ISBN 978-92-0-100719-3

STI/PUB/1846 • €35.00

This publication identifies issues and challenges relevant to the development and implementation of options, policies, strategies and programmes for ensuring safe, secure, and effective storage of spent fuel until transport to reprocessing or disposal. The target audience of this publication includes policy and decision makers who need to be aware of the implicit risks and costs associated with decision timing for determining and implementing an end point for spent fuel management (such as reprocessing or disposal) to ensure the responsible and sustainable use of nuclear energy. The publication will assist those within the nuclear industry in communicating the importance of a clear, credible and sustainable spent fuel management strategy and will encourage decision makers to consider different approaches that may be useful in addressing the uncertainties resulting from an unknown storage duration and an undefined end point for spent fuel management.

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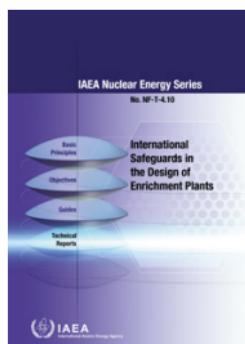
Enhancing Benefits of Nuclear Energy Technology Innovation through Cooperation among Countries: Final Report of the INPRO Collaborative Project **SYNERGIES**

IAEA Nuclear Energy
Series No. NF-T-4.9

(341 pp., 227 figs; 2018)
ISBN 978-92-0-101118-3
STI/PUB/1807 • €66.00

This publication provides a summary of the INPRO collaborative project on synergistic nuclear energy regional group interactions evaluated for sustainability. Benefits of nuclear technology innovation can be amplified through co-operation among countries in the nuclear fuel cycle. Nuclear energy sustainability can be enhanced, not only for technology holders but also for a variety of technology users, including those who do not pursue innovations in their home countries. If one partner in a synergistic collaboration is achieving enhanced sustainability, then the other partner(s) may achieve similar enhancement through collaboration without the requisite large national investments in technology, R&D and related infrastructure development. Within the publication, 28 case studies have been conducted by Member States to identify and evaluate mutually beneficial patterns of co-operation in the nuclear fuel cycle and the driving forces and impediments involved in such co-operation.

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International Safeguards in the Design of Enrichment Plants

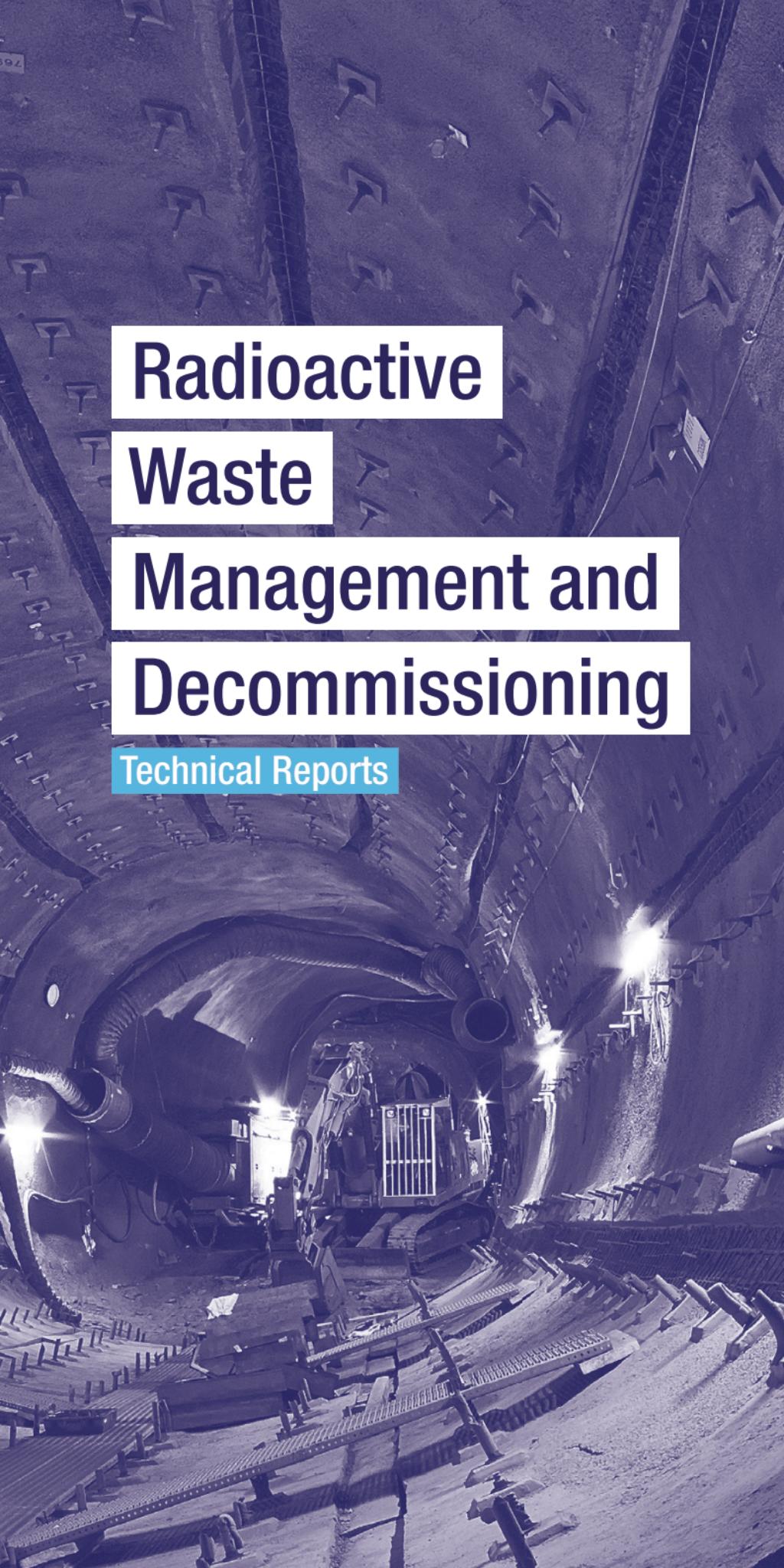
IAEA Nuclear Energy
Series No. NF-T-4.10

(44 pp., 11 figs; 2019)
ISBN 978-92-0-104419-8
STI/PUB/1865 • €35.00

This publication is part of a series that aims to inform nuclear facility designers, vendors, operators and State governments, about IAEA safeguards and how associated requirements can be considered early in the design phase of a new nuclear facility. This particular publication is applicable to the design and construction of commercial uranium enrichment plants. Safeguards by design dialogue undertaken early in the design and construction of enrichments plants facilitates the implementation of safeguards throughout all the lifecycle stages of the facility. The potential to reduce costs, avoid retrofits and achieve efficiencies both for the operator and for IAEA Member States, are important drivers for the early consideration of safeguards in a nuclear facility design project.

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IAEA Nuclear Energy Series No. NW-T-1.14
- NW-T 60** Options for Management of Spent Fuel and Radioactive Waste for Countries Developing New Nuclear Power Programmes
IAEA Nuclear Energy Series No. NW-T-1.24 (Rev. 1)
- NW-T 61** Costing Methods and Funding Schemes for Radioactive Waste Disposal Programmes
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- NW-T 62** Design Principles and Approaches for Radioactive Waste Repositories
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- NW-T 66** Developing Cost Estimates for Environmental Remediation Projects
IAEA Nuclear Energy Series No. NW-T-3.8

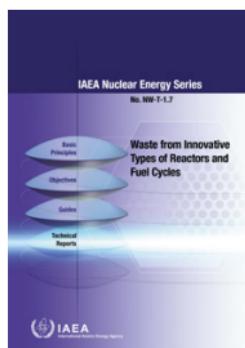


Radioactive

Waste

**Management and
Decommissioning**

Technical Reports



Waste from Innovative Types of Reactors and Fuel Cycles

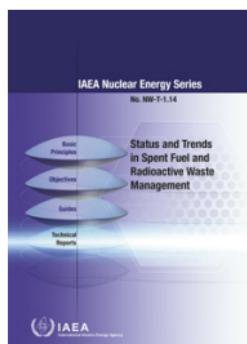
A Preliminary Study

**IAEA Nuclear Energy
Series No. NW-T-1.7**

(117 pp., 32 figs; 2019)
ISBN 978-92-0-102818-1
STI/PUB/1822 • €41.00

For reactors currently operating, the types of wastes expected to be generated under normal operating regime are known and, aside from a few problematic wastes (such as graphite, tritium and radiocarbon) most of these wastes have clearly defined cradle-to-grave (end-to-end) pathways. However, for advanced and innovative reactors and their fuel cycles, some waste types may either have new or different properties or might be problematic for processing with the currently available technologies. One of the primary challenges for advanced and innovative reactors and their nuclear fuel cycles is that solutions must be identified for all eventually problematic wastes prior to initiating construction of these facilities. This publication sets the stage for considering the waste generation of advanced fuel fabrication, reactor operation and decommissioning, reprocessing of spent fuel and waste pathways early in the development of new reactors and their associated fuel cycles. It describes waste flows in broad chemical and physical terms and identifies possible processing, recycling and disposition pathways. The publication is intended to support the nuclear industry in taking an early and integrated approach to waste management.

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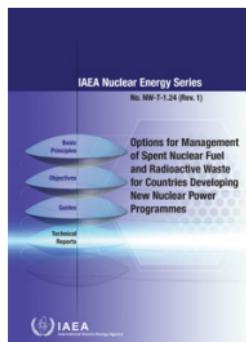
Status and Trends in Spent Fuel and Radioactive Waste Management

**IAEA Nuclear Energy
Series No. NW-T-1.14**

(57 pp., 25 figs; 2018)
ISBN 978-92-0-108417-0
STI/PUB/1799 • €39.00

Based on the outcome of a collaborative project undertaken by the IAEA, OECD-NEA and the European Commission, this publication provides a global overview of the status of radioactive waste and spent fuel management concerning inventories, programmes, current practices, technologies and trends. It includes an analysis of national arrangements and programmes for radioactive waste and spent fuel management, an overview of current waste and spent fuel inventories and estimates of future amounts. International and national trends in these areas are also addressed.

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Options for Management of Spent Fuel and Radioactive Waste for Countries Developing New Nuclear Power Programmes

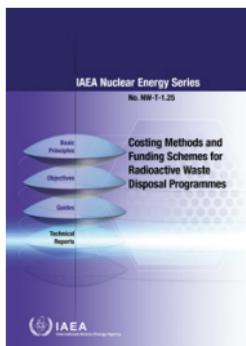
**IAEA Nuclear Energy
Series No. NW-T-1.24
(Rev. 1)**

(56 pp., 9 figs; 2018)
ISBN 978-92-0-103118-1
STI/PUB/1825 • €32.00

Many countries are considering the construction of their first nuclear power plant or the expansion of a small nuclear power programme, and some have limited experience in managing radioactive waste and spent nuclear fuel. The present revised publication provides a concise summary of key issues related to the development of a sound radioactive waste and spent nuclear fuel management system. It is intended to brief countries with small or newly established nuclear power programmes about the challenges of, and to describe current and potential alternatives for, managing reactor waste and spent fuel arising during operation and decommissioning of nuclear power plants.

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Forthcoming



Costing Methods and Funding Schemes for Radioactive Waste Disposal Programmes

**IAEA Nuclear Energy
Series No. NW-T-1.25**

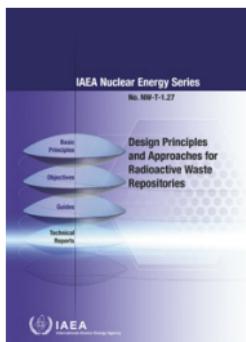
ISBN 978-92-0-108819-2

STI/PUB/1900 • €40.00

Reliable methods for estimating the cost of a radioactive waste disposal programme are crucial to ensure that the necessary funding for completing the disposal programme is available. Estimating the cost for disposal is however a challenging and complex task. Disposal programmes themselves are complex and long term undertakings and conditions can be expected to change significantly over the time span during which a disposal programme is developed and implemented. This publication provides Member States with guidance on how to develop cost estimates for a disposal programme and on how to establish funding mechanisms. It will help readers in becoming informed clients by familiarizing themselves with the approaches and complexities in cost estimates and funding mechanisms for disposal. The publication is applicable to all waste categories and both near surface and geological disposal. It contains relevant examples and case studies from national programmes. The cost figures are intended to give an indication of the possible cost of certain parts or aspects of the disposal programme rather than to compare different disposal programmes' costs.

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Forthcoming



Design Principles and Approaches for Radioactive Waste Repositories

**IAEA Nuclear Energy
Series No. NW-T-1.27**

ISBN 978-92-0-112920-8

STI/PUB/1908 • €32.00

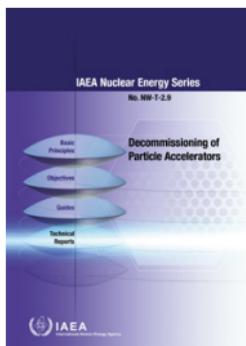
A considerable level of international experience has been gained over the last decades in designing radioactive waste disposal facilities. This publication is intended to assist Member States in planning for the disposal of radioactive waste. Specifically, this publication describes the approaches and principles to be considered by the responsible organizations within a Member State involved in the planning and design of radioactive waste disposal facilities. Examples are provided for all waste classes requiring disposal. The examples are based on successfully implemented designs or on design concepts that are sufficiently advanced to demonstrate their overall feasibility for the safe disposal of radioactive waste. Alternate disposal options are also discussed, describing solutions that rely on the conversion of existing facilities, such as mines or other underground openings as well as the potential for disposal in boreholes.

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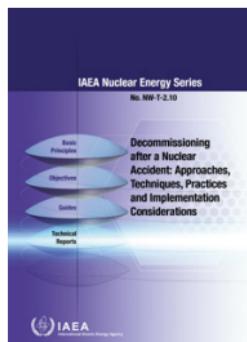
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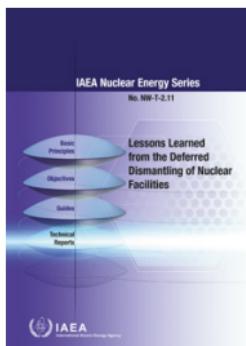
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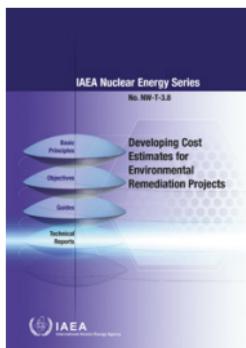
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The publication discusses the issues that must be dealt with when preparing the facility for safe enclosure, or safely maintaining it for a long time. It provides details of lessons learned from deferred decommissioning of nuclear facilities following planned shutdown. These lessons have been learned from a variety of facilities, with a variety of hazards, configurations and decommissioning programmes. While some of the considerations addressed may apply to facilities involved in an operating incident or accident, they are not specifically addressed by this publication as the individual nature of their hazards and decommissioning challenges precludes their use as exemplars. The publication addresses the preparation for, and the steady state part of the safe enclosure phase; it should be understood that in a later part of that phase the on- and off-site requirements and arrangements will change as plans and infrastructure are prepared for the next phase, which is the final dismantling, remediation and site release.

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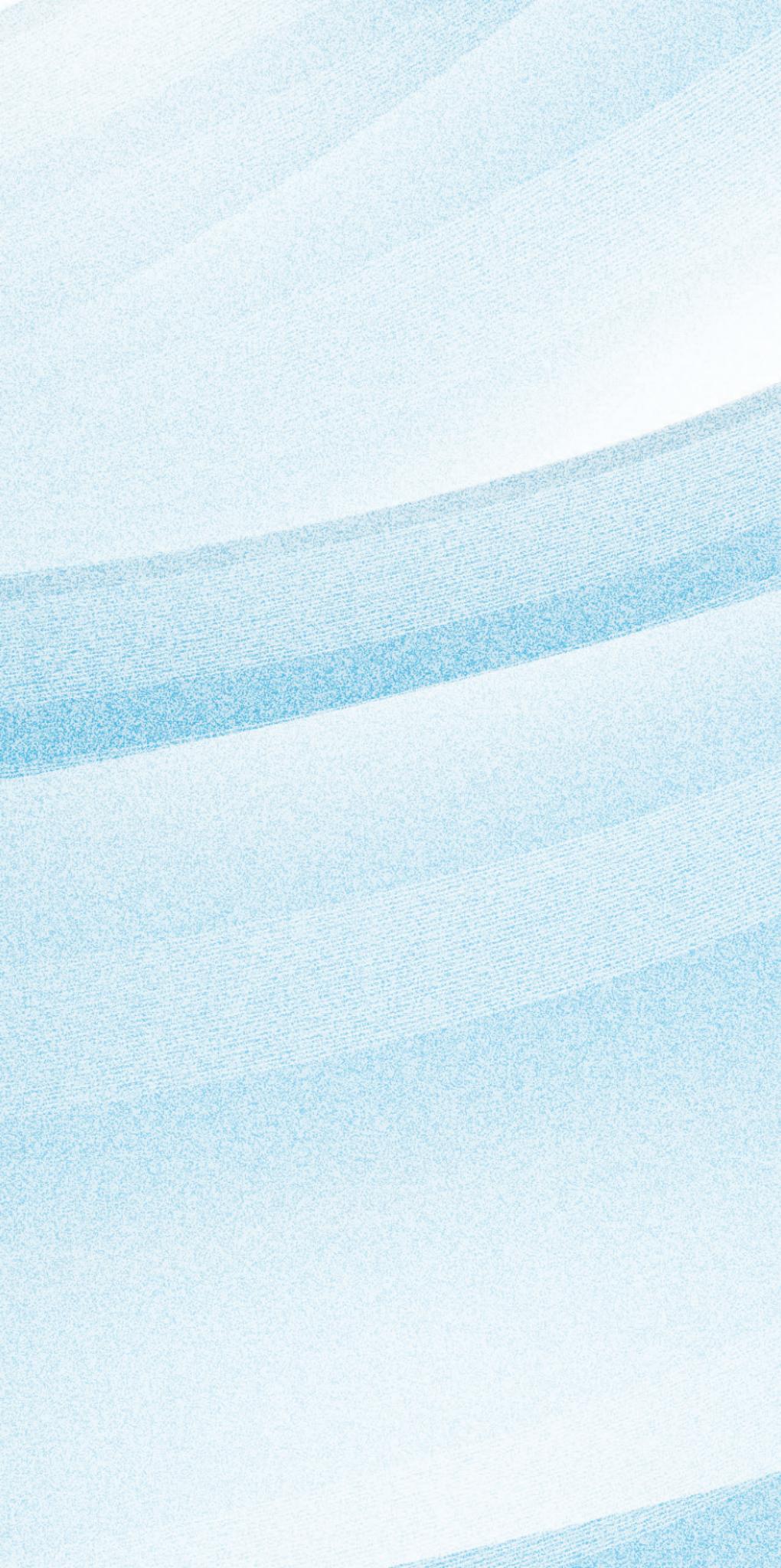
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