IAEA Nuclear Energy Series

No. NW-O

Basic Principles

Objectives

Guides

Technical Reports

Radioactive Waste Management Objectives

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International Atomic Energy Agency

IAEA NUCLEAR ENERGY SERIES PUBLICATIONS

STRUCTURE OF THE IAEA NUCLEAR ENERGY SERIES

Under the terms of Articles III.A 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** provide information in the areas of nuclear power, nuclear fuel cycle, radioactive waste management and decommissioning, and on general issues that are relevant to all of the above mentioned areas. The structure of the IAEA Nuclear Energy Series comprises three levels: **1 — Basic Principles and Objectives; 2 — Guides; and 3 — Technical Reports.**

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

Nuclear Energy Series Objectives publications explain the expectations to be met in various areas at different stages of implementation.

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

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The IAEA Nuclear Energy Series publications are coded as follows: **NG** — general; **NP** — nuclear power; **NF** — nuclear fuel; **NW** — radioactive waste management and decommissioning. In addition, the publications are available in English on the IAEA's Internet site:

http://www.iaea.org/Publications/index.html

For further information, please contact the IAEA at PO Box 100, Vienna International Centre, 1400 Vienna, Austria.

All users of the IAEA Nuclear Energy Series publications are invited to inform the IAEA of experience in their use for the purpose of ensuring that they continue to meet user needs. Information may be provided via the IAEA Internet site, by post, at the address given above, or by email to Official.Mail@iaea.org.

RADIOACTIVE WASTE MANAGEMENT OBJECTIVES

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The Agency's Statute was approved on 23 October 1956 by the Conference on the Statute of the IAEA held at United Nations Headquarters, New York; it entered into force on 29 July 1957. The Headquarters of the Agency are situated in Vienna. Its principal objective is "to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world''.

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RADIOACTIVE WASTE MANAGEMENT OBJECTIVES

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FOREWORD

One of the IAEA's statutory objectives is to "seek to accelerate and enlarge the contribution of atomic energy to peace, health and prosperity throughout the world". One way it achieves this objective is to issue publications in various series. Two of these series are the IAEA Nuclear Energy Series and the IAEA Safety Standards Series.

According to Article III, paragraph A.6, of the IAEA Statute, the IAEA safety standards establish "standards of safety for protection of health and minimization of danger to life and property." The safety standards include the Safety Fundamentals, Safety Requirements and Safety Guides. These standards are primarily written in a regulatory style, and are binding on the IAEA for its own activities. The principal users are Member State regulatory bodies and other national authorities.

The IAEA Nuclear Energy Series consists of reports designed to encourage and assist research on, and development and practical application of, nuclear energy for peaceful uses. This includes practical examples to be used by owners and operators of utilities in Member States, implementing organizations, academia and politicians, among others. The information is presented in guides, reports on the status of technology and advances, and best practices for peaceful uses of nuclear energy based on inputs from international experts. The series complements the IAEA's safety standards, and provides detailed guidance, experience, good practices and examples on the five areas covered in the IAEA Nuclear Energy Series.

The Nuclear Energy Basic Principles is the highest level publication in the IAEA Nuclear Energy Series and describes the rationale and vision for the peaceful uses of nuclear energy. It presents eight Basic Principles on which nuclear energy systems should be based to fulfil nuclear energy's potential to help meet growing global energy needs.

The Nuclear Energy Series Objectives are the second level publications. They describe what needs to be considered and the specific goals to be achieved at different stages of implementation, all of which are consistent with the Basic Principles. The four Objectives publications include Nuclear General Objectives, Nuclear Power Objectives, Nuclear Fuel Cycle Objectives, and Radioactive Waste Management and Decommissioning Objectives.

This publication sets out the objectives that need to be achieved in the area of radioactive waste management, including decommissioning and environmental remediation, to ensure that the Nuclear Energy Basic Principles are satisfied.

The IAEA expresses its gratitude to the many experts who contributed to the drafting of this publication. The IAEA officer responsible for this publication was L. Nachmilner of the Department of Nuclear Energy.

EDITORIAL NOTE

CONTENTS

1. INTRODUCTION

1.1. BACKGROUND

The IAEA's Nuclear Energy Basic Principles publication [1] presents the basic principles on which nuclear energy systems should be based to fulfil nuclear energy's potential to help meet growing global energy needs. The Basic Principles are intended to provide a broad and holistic approach to the use of nuclear energy, and to be equally applicable to all essential elements of nuclear energy systems, including human, technical, management and economic aspects, with due regard to the protection of people and the environment, non-proliferation and security.

The following paragraphs present an overview of the Basic Principles.

Beneficial use

— **Benefits.** The use of nuclear energy should provide benefits that outweigh the associated costs and risks.
— **Transparency.** The use of nuclear energy should be based on open and transparent communication of all its facets.

Responsible use

— **Protection of people and the environment.** The use of nuclear energy should be such that people and the environment are protected in compliance with internationally recognized standards.
— **Security.** The use of nuclear energy should take due account of the risk of malicious use of nuclear and other radioactive material.
— **Non-proliferation.** The use of nuclear energy should take due account of the risk of the proliferation of nuclear weapons.
— **Long term commitment.** The use of nuclear energy should be based on a long term commitment.

Sustainable use

— **Resource efficiency.** The use of nuclear energy should be efficient in using resources.
— **Continual improvement.** The use of nuclear energy should be such that it pursues advances in technology and engineering to continually improve

safety, security, economics, proliferation resistance, and protection of the environment.

1.1.1. Radioactive waste management

In general, the Nuclear Energy Objectives describe what needs to be considered and achieved in different stages of technology implementation in a particular area to comply with the Basic Principles. This publication formulates the objectives for the area of radioactive waste management.

Radioactive waste arises from the following activities:

— Operation of nuclear power plants used for the power generation or research reactors;
— Processes for producing nuclear fuel and its reprocessing;
— Decommissioning of nuclear facilities;
— Remediation of areas contaminated as a result of past nuclear activities, for example, nuclear weapons production and testing, the mining and milling of uranium, or nuclear incidents and accidents.

In addition, radioactive waste, mainly in the form of disused sealed radioactive sources, results from the use of radioisotopes in medicine, research and industry. In recent years, it has been increasingly recognized that the residues from industries using and processing naturally occurring radioactive material (NORM) should also be managed as radioactive waste, even if the protection levels may differ. Spent nuclear fuel is regarded as a resource by some countries and as a radioactive waste by others. Irrespective of how it is considered, it must be safely managed until it is reprocessed or placed in a geological repository.

Special arrangements for the management of radioactive waste are necessary because of the radiological hazards associated with it. The preferred strategy is to contain the waste (i.e. to confine the radionuclides within the waste matrix, the packaging and the disposal facility) and to isolate it from the immediate environment in which humans live. Radioactive waste management therefore consists of collecting the radioactive waste, processing it into a form that can be stored safely, and then storing it, pending its final disposal, in surface or geological repositories. While most radioactive waste is in solid form, gaseous and liquid radioactive waste is also generated. Waste with activity below the authorized limits may be discharged under controlled conditions that ensure the protection of the public and the environment.

It is increasingly recognized that, when planning or designing nuclear installations, all the associated implications must be considered—both immediate and long term. The generation of radioactive waste and the subsequent need to manage it, is one of the implications, and learning from past experience, greater emphasis should be given to planning for the minimization of waste generation and optimization of its management, as well as for its financing. In doing this, the whole life cycle of radioactive waste, starting with its generation and ending with its emplacement in a repository, needs to be considered.

An important aspect of radioactive waste management is the timescales that have to be considered for some of this waste. Human and environmental protection have to be ensured over very long timescales, from decades, in cases where the decommissioning of a nuclear installation is deferred, to many thousands of years in the case of geological disposal of intermediate and high level radioactive waste. Thus, there has to be a long term commitment to creating and maintaining efficient infrastructure in the schemes and strategies for radioactive waste management involving adequate active and passive measures.

1.2. PURPOSE AND SCOPE

The purpose of this publication is to set out the objectives of radioactive waste management required in order to satisfy the Nuclear Energy Basic Principles [1]. For the IAEA, the objectives are intended to provide a framework for the design of programmes regarding radioactive waste management technology and a basis for the development of the guidance on radioactive waste management, decommissioning and environmental remediation within the IAEA Nuclear Energy Series.

The IAEA has developed a separate series of publications concerned with the safety, security and non-proliferation of radioactive waste management: the IAEA Safety Standards Series, IAEA Nuclear Security Series, and Safeguards Information Series. The IAEA Nuclear Energy Series publications are intended to provide guidance on strategies, methods and technologies that will, together with the other IAEA publications, ensure efficient and effective technical solutions and the required level of safety (radiological and non-radiological), security and non-proliferation while managing radioactive waste.

In this publication, radioactive waste management is taken to include all the steps for managing radioactive waste originating from:

— The operation and decommissioning of nuclear energy facilities;
— The use of radioisotopes in medicine, research and industry;
— The remediation of areas and buildings affected by radioactive contamination from past and ongoing activities and accidents.

2. OBJECTIVES FOR RADIOACTIVE WASTE MANAGEMENT, DECOMMISSIONING AND ENVIRONMENTAL REMEDIATION

2.1. INTRODUCTION

The objectives that derive from each of the Nuclear Energy Basic Principles are presented in what follows as they apply to the area of radioactive waste management.

2.2. OBJECTIVES

Basic Principle: Benefits

Objective: *Minimization of generation and optimization of the management of radioactive waste.*

The main benefit of nuclear energy is in the electricity produced from it, while the management of radioactive waste generated in the process of electricity production is one of its costs. Similarly, the benefits from the applications of radioisotopes include improved human health and technical advantages in research and industry, while the resulting radioactive waste is a cost. The overall benefit of nuclear energy and isotope applications is therefore enhanced, if radioactive waste generation is minimized by proper measures applied at source and during its processing and the waste is optimally (i.e. safely and cost effectively) managed. Radioactive waste generation can be minimized in various ways, for example:

- By improved design of uranium mining and milling operations;
- By improved designs of nuclear reactors that reduce radioactive waste generation and discharges to the environment;
- By optimization of nuclear facility operations;
- By increasing the reuse and recycle of materials from decommissioning;
- By improved radioactive source accounting and security and management methods; and
- By improved waste volume reduction and decontamination techniques.

Efforts towards minimizing the generation of radioactive waste should be encouraged as a means of reducing the costs of nuclear technology and saving resources. Despite these schemes, some radioactive waste will inevitably be generated. By optimizing the technologies used for radioactive waste management, the associated costs can be kept to a minimum, taking due account of the other relevant factors, such as safety, security, non-proliferation, feasibility, public acceptability, and sustainability.

It is important, therefore, that each country has national strategies in place for the cost effective management of all types of waste generated in that country [2]. The range of available waste management methods is broad, but they should be chosen so that the methods are optimal for particular waste types.

Lessons have been learned from the early years of nuclear energy development and application when insufficient attention was paid to radioactive waste management, with the result that larger than necessary volumes of waste were created and inefficient management solutions were often applied. In the context of planning or designing nuclear installations, it is nowadays widely recognized that the minimization of radioactive waste generation and its optimized management are important considerations throughout their whole life cycle.

Waste management also often needs to be implemented after the benefits of the use of nuclear technologies have come to an end. Thus, it is important to have an appropriate funding system in place to ensure the availability of financing radioactive waste management when required.

Basic Principle: Transparency

Objective: *Establishment of methods and approaches for building trust among persons involved and affected by the management of radioactive waste.*

Issues surrounding radioactive waste management, in particular, the siting of radioactive waste repositories, have raised concerns among the public. Experience has shown that progress towards the goal of optimally and safely managing and disposing of radioactive waste can only be made if the concerned members of the public believe and respect the persons and organizations responsible for implementing the waste management procedures and are convinced that the planned procedures are effective and safe. To build this trust, the concerned persons, the ‘stakeholders’, many of whom have no formal role in the decision making process, have to see that their views are being taken seriously and that they can influence events.

Openness and transparency in relation to planning and decision making are key elements in building trust. This includes making pertinent information freely and easily available, and providing easy access for those wishing to ask questions. Openness and consistency in speech and action are therefore key requirements for implementers of decisions and operators.

Trust in the national system for radioactive waste management is enhanced by the existence, in the country, of an effective regulatory framework and an independent regulatory body that is also seen by stakeholders to be independent and trustworthy.

The type of strategy and methods to be used for building trust must take account of the nature of governance and culture of the Member State and of its civil and administrative traditions. In some Member States, provisions for public participation have already been formalized through national and international legislation or through association with international conventions, such as the Aarhus Convention [3] and the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management (the Joint Convention) [4].

Basic Principle: Protection of people and the environment

Objective: *Implementation of radioactive waste management methods that ensure the protection of people and the environment.*

Radioactive waste is potentially hazardous and it must be managed in ways that ensure the protection of the public and the environment for as long as it remains hazardous. Policies for safely managing radioactive waste have been agreed internationally and are set out in the IAEA safety standards [5] and in the Joint Convention [4]. Obviously, international standards dealing with non-radiological safety matters shall also be respected whenever applicable.

Technologies have been developed for handling, processing, storing and disposing of radioactive waste so as to ensure that people and the environment are protected in compliance with the requirements of the Safety Standards. Well established infrastructures are in place in most countries to provide for the implementation of safe management procedures for radioactive waste.

However, while appropriate management techniques have been developed for most types of radioactive waste, there are some areas where additional attention is needed to ensure that the public and environment are properly protected. For example, in some countries, problematic waste streams exist that may require technology development, disused sealed radioactive sources that have not been properly controlled and managed and, in others, land areas affected either by uranium mining and milling or by past nuclear incidents or accidents that have yet to be remediated. In these situations technology enhancement and development are necessary to ensure adequate protection of the public.

Some waste from nuclear power operations is being stored pending its final disposal. Similarly, some nuclear reactors being decommissioned still contain significant inventories of radioactive materials. In both these cases, the waste can be regarded as being in safe storage, but in a condition that requires regular maintenance and human supervision. In order to guarantee the long term protection of the public and the environment, efforts are needed to move such waste to a state of passive safety, for example, as provided by disposal.

Basic Principle: Security

Objective: *Implementation of physical protection systems relevant to radioactive waste.*

Some types of radioactive material, although considered to be waste, can still pose a security threat. Examples are disused high activity radioactive sources and spent nuclear fuel. Today, there is a growing concern that terrorist or criminal groups could gain access to such material and use it with harmful intent. Consequently, there has been a global trend towards increased control, accounting and security measures to prevent this happening.

To address these issues, the IAEA provides guidance and recommendations through the IAEA Nuclear Security Series and direct contacts with Member States on the security of radioactive waste [6, 7]. The recommendations from these publications and services are based on a set of fundamental security principles and a methodology that considers the consequences of security related events with respect to the State's assessment of the threat in order to establish physical protection criteria that are balanced, and provides in-depth security and whose performance is graded by the severity of consequence.

The application of nuclear security principles to the early stages of design and implementation of new radioactive waste management facilities has the potential to increase security, decrease operational impact, lower operating costs and allow for greater integration with safety and safeguards systems. The extent of potential consequences from the occurrence of security related events depends, to a large extent, upon the types and amounts of radioactive material being held.

Additionally, there should be continuing awareness and alertness among all staff, including operators and regulators, to prevent the misuse of radioactive waste.

It is obvious that security and safety measures are designed and implemented in an integrated manner so that they are not mutually compromised.

Basic Principle: Non-proliferation

***Objective**: Incorporation of nuclear safeguards requirements in the design and operation of radioactive waste management facilities.*

Spent nuclear fuel from research and power reactors, and radioactive waste containing nuclear material, could be processed and the recovered nuclear material used in the production of nuclear weapons. International safeguards obligations and requirements for reporting and verification of nuclear material are defined in the safeguards agreements in force between a State and the IAEA [8–10]. These requirements apply to all locations at which such material is used or stored and to disposal facilities containing these spent fuel and waste. The safeguards system, and the implemented safeguards measures, must provide assurance that nuclear material has not been diverted.

The IAEA's safeguards requirements are to be considered in the design and operation of all radioactive waste and spent fuel management facilities containing nuclear material. These requirements will consider State specific, facility specific and material specific factors such that they can be implemented without compromising the safety of the facilities and minimizing impacts on operations [11, 12].

Basic Principle: Long term commitment

***Objective:** Development of solutions that provide for the long term management of radioactive waste.*

Radioactive waste is a long term challenge that has to be properly addressed. This has been recognized for many years and technical solutions have been developed for the processing and disposal of all types of waste. However, in many countries there have been delays in the development of repositories for the disposal of radioactive waste and, as a result, the waste is stored for specific period of time. It is important that clear strategies are developed to proceed with disposal at the appropriate time.

The long lived radionuclides present in some waste types require management solutions that, although passively safe, may require surveillance in the future. Examples of these are geological repositories for intermediate and high level radioactive waste and the impoundments for uranium mining and milling residues. To ensure the long term institutional control of such waste management systems, responsibilities should be clearly allocated and provisions should be made for the availability of the necessary technical and human resources and for sufficient financial resources over appropriate timescales.

Adaptive solutions may also be required to meet the potential needs of future generations.

The legacy from the early nuclear era and early nuclear weapons production and testing has left many areas of the world affected by radioactive contamination due to poorly managed uranium mining operations, accidents at production facilities, and from weapon testing. As part of a long term commitment and to the extent possible, these areas should be remediated with priority given to the areas with people living in the vicinity.

Basic Principle: Resource efficiency

***Objective**: Promotion of radioactive waste management methods and schemes that save resources and utilize them efficiently.*

Many opportunities exist to reduce the use of resources in managing radioactive waste. One of the most obvious areas is the segregation, recycling and reuse of materials that might otherwise be declared as waste during the operation and decommissioning of nuclear facilities, either directly, if not contaminated, or after decontamination or storage for decay to reach acceptable levels. Similarly, innovative techniques are needed for the decontamination of buildings and cleanup of contaminated land to permit their release for unrestricted use and development. Natural resources are also saved by generating less waste through optimization of processes, resulting in the reduction of the size of storage and disposal facilities.

Spent nuclear fuel can be declared as radioactive waste, in which case it is subjected to appropriate conditioning prior to disposal, or it can be considered as a resource for further use (reprocessing/partitioning or feed for other reactors).

Decisions on resource saving measures have to be made as part of a comprehensive radioactive waste and spent fuel management policy and strategy taking into consideration many factors, not least the financial and feasibility aspects. This may sometimes limit the potential for resource saving.

Basic Principle: Continual improvement

***Objective:** Steady improvement of methods and technologies in radioactive waste management.*

The methods and technologies used for radioactive waste management have been developed over a fifty year period and are generally well established, but it is important that efforts continue to be made to improve upon them. The aim should be to develop methods and technologies that improve the efficiency of long term radioactive waste management and that reduce costs while ensuring the required level of safety.

Research and development is taking place in Member States on a variety of topics related to improving the management of radioactive waste and correcting uncertainties in accepted solutions. Topics include:

— Reducing the long lived components of waste by using advanced chemical and nuclear techniques;
— Improving methods for rendering waste into stable, durable forms by chemical processing;
— Improving techniques for the containment and isolation of waste;
— Optimizing the disposal routes for different waste types;
— Assessing the long term performance of site remediation strategies.

Research and development can be encouraged and made more effective through international collaborative projects and by the effective dissemination of results.

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Annex

SUMMARY TABLE OF OBJECTIVES FOR EACH NUCLEAR ENERGY BASIC PRINCIPLE (BP)

BP	Energy system analysis and development of strategies for nuclear energy	Economics	Infrastructure	Management systems	Human resources	Knowledge management
1. BENEFITS	Energy systems analysis and development of strategies for nuclear energy consider options which lead to a system that delivers affordable, secure and clean energy services; and that the potential of nuclear energy for meeting future energy needs is analysed with its specific characteristics and requirements for technological and institutional development.	The economic analysis and evaluation of nuclear energy compare alternatives that cover the social costs and benefits on a lifetime basis, as well as the commercial and financial viability of nuclear energy projects.	National infrastructure for nuclear energy systems supports effective economical, safe, and secure implementation and operation, in a manner that provides societal benefits at an affordable cost and with minimal and acceptable risks.	Organizations in the nuclear field establish and implement a management system which includes the arrangements and processes necessary to achieve all the goals of the organization in a cost effective and integrated manner.	Organizations in the nuclear energy field develop and maintain the highest levels of performance and competence of their personnel commensurate with the risks associated with nuclear technologies	Nuclear knowledge management strategies are formulated, adopted and implemented at a level aimed at enhancing the benefits of nuclear power systems to society at large.
2. TRANSPARENCY	The energy systems analysis and development of strategies for nuclear energy are presented and discussed in an open and transparent manner, engaging stakeholders and the public, by organizations in the nuclear field.	The economic assessment of nuclear energy is conducted in an open and transparent manner, with results reported to the public.	Infrastructure development for nuclear energy systems is done in a manner that provides openness and transparency, and acceptance by the public.	The management system considers the expectations of interested parties and the system is implemented in such a way as to foster a culture of openness and transparency at all levels in the organization.	Public communication activities are organized in such a way as to provide openness and transparency in the use of nuclear technologies.	Knowledge management programmes provide for the use of nuclear knowledge in a transparent way and also for its social acceptance.

BP	Energy system analysis and development of strategies for nuclear energy	Economics	Infrastructure	Management systems	Human resources	Knowledge management
3. PROTECTION OF PEOPLE AND THE ENVIRONMENT	The energy systems analysis and development of strategies for nuclear energy of the Member States give credit for strengthening and achieving higher levels of protection of the public and the environment from adverse impacts of energy conversion and use.	The economic assessment of nuclear energy includes the costs associated with the protection of people and the environment.	Development of infrastructure for nuclear energy systems includes legal and regulatory arrangements and competencies necessary to protect people and the environment, consistent with the IAEA Safety Standards	The management system is designed to fulfil the requirements that must be met for the protection of people and the environment during all stages of the lifetime of nuclear energy systems.	Organizations in the nuclear field ensure that the personnel develop and maintain the competences needed to comply with the IAEA Safety Standards relating to the protection of people and the environment.	Dedicated knowledge management programmes are applied, which are aimed at enhancing the safety of nuclear installations and the protection of people and the environment.
4. SECURITY	The energy systems analysis and development of strategies for nuclear energy address security concerns relating to different energy options and includes in the analysis necessary improvements in technical, regulatory and institutional areas.	The economic assessment of nuclear energy includes the costs associated with ensuring nuclear security.	Development of the infrastructure for nuclear energy systems includes provisions for suitable protection against theft or malevolent acts.	The management system is designed to fulfil all requirements that must be met for the security of nuclear energy systems in all stages of their lifetime.	Organizations in the nuclear field ensure that the personnel develop and maintain the competences necessary to comply with national and IAEA guidelines related to nuclear security.	Knowledge management programmes are designed and implemented to exclude information thefts and other malicious acts affecting nuclear installations and materials, and with the aim of enhancing security.

BP	Energy system analysis and development of strategies for nuclear energy	Economics	Infrastructure	Management systems	Human resources	Knowledge management
5. NON-PROLIFERATION	The energy systems analysis and development of strategies for nuclear energy include the assessment of proliferation concerns and non-proliferation benefits.	The economic assessment of nuclear energy includes the costs associated with preventing the proliferation of nuclear weapon technologies.	Infrastructure development for nuclear energy systems includes provisions to prevent the proliferation of nuclear weapon technologies.	The management system implements the arrangements needed for the accounting for and control of nuclear material, ensures that all necessary arrangements are in place to comply with national safeguard obligations and are effectively fulfilled in a timely manner.	Organizations in the nuclear field develop and maintain the human resources needed to plan and implement appropriate safeguard arrangements, in such a way as to prevent the proliferation of nuclear weapon technologies.	Knowledge management programmes identify and protect confidential and classified knowledge and information, and ensure that their use is in accordance with international obligations in relation to the non-proliferation of nuclear weapons and ensures continuity of safeguards information.
6. LONG TERM COMMITMENT	The energy systems analysis and development of strategies for nuclear energy include the evaluation of technical, economic, institutional and regulatory requirements, and commitments on a long term basis and covering the entire fuel cycle.	The economic assessment of nuclear energy includes the costs associated with the entire lifetime of the nuclear facilities, including decommissioning and waste disposal.	Development of infrastructure for nuclear energy systems is done with consideration of the entire lifetime of nuclear facilities, including suitable decommissioning and waste disposal plans.	The management system recognizes and plans for the entire lifetime of nuclear technologies and their long term consequences.	Organizations in the nuclear field plan for their future staffing, competence and performance related needs for the complete lifetime of their nuclear facilities.	Knowledge management systems maximize the flow of nuclear knowledge from one generation to the next, and attract, maintain and further develop a dedicated body of highly competent professional staff, in order to sustain nuclear competence over the entire lifetime of nuclear installations.

BP	Energy system analysis and development of strategies for nuclear energy	Economics	Infrastructure	Management systems	Human resources	Knowledge management
7. RESOURCE EFFICIENCY	The energy systems analysis and development of strategies for nuclear energy include the assessment of the efficiency of resource use, and the identification of technical innovations to improve the efficiency of resource use.	The economic assessment of nuclear energy fully takes into account the use of natural and economic resources.	Infrastructure development for nuclear energy systems includes the optimal use of resources for the implementation of nuclear technologies.	The management system ensures effective resource planning and utilization throughout the entire lifetime of the use of nuclear technology.	Organizations in the nuclear field organize their activities so as to make optimal use of resources for the implementation of nuclear technologies	Nuclear knowledge is managed as a basic economic resource, and includes three fundamental components: personnel, processes and technology, for all stages of the nuclear fuel cycle.
8. CONTINUAL IMPROVEMENT	The energy systems analysis and development of strategies for nuclear energy provide for the continual improvement of the sustainability of energy services in terms of safety, affordability, reliability, security and environmental compatibility.	Nuclear energy systems strive for continual improvement regarding economics and safety.	Develop nuclear energy systems in such a manner as to continually improve the infrastructure, taking into account lessons learned both nationally and internationally.	The management system systematically develops and implements plans for continual improvement.	Organizations and individuals in the nuclear field continually strive to improve their performance.	Knowledge management is applied as a key driver for continual improvement.

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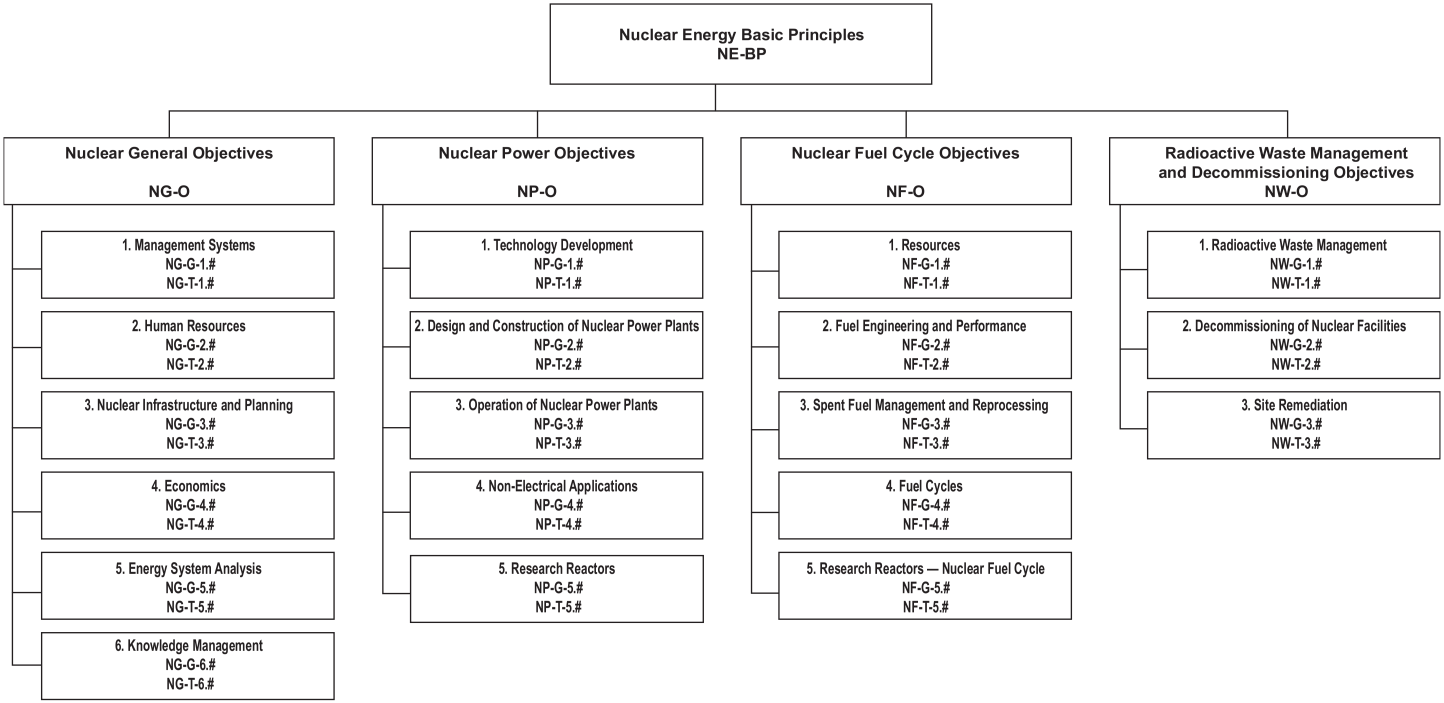

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