IAEA Nuclear Energy Series

NE-BP


# Nuclear Energy Basic Principles

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International Atomic Energy Agency

# NUCLEAR ENERGY
# BASIC PRINCIPLES

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IAEA NUCLEAR ENERGY SERIES No. NE-BP

# NUCLEAR ENERGY BASIC PRINCIPLES

INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA, 2008

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tel.: +43 1 2600 22417
email: sales.publications@iaea.org
http://www.iaea.org/books

© IAEA, 2008

Printed by the IAEA in Austria
December 2008
STI/PUB/1374

**IAEA Library Cataloguing in Publication Data**

Nuclear energy basic principles. — Vienna : International Atomic Energy Agency, 2008.
p. ; 29 cm. — (IAEA nuclear energy series, ISSN 1995-7807 ; no. NE-BP)
STI/PUB/1374
SBN 978–92–0–112608-5
Includes bibliographical references.

1. Nuclear energy — Safety measures. 2. Nuclear energy — Security measures. I. International Atomic Energy Agency. II. Series.

IAEAL 08–00557

# 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". In order to support the different needs of its Member States in this endeavour, the Agency developed the *IAEA Nuclear Energy Series* of publications. This series complements other publications, such as those in the IAEA Safety Standards Series, the IAEA Nuclear Security Series, those dealing with safeguards, and publications issued by other organizations on industrial safety, protection of the environment, management systems and related aspects of energy generation. The series recognizes that Member States have different requirements with regard to the use of nuclear technology. Those without nuclear power programmes need information and guidance on the availability, benefits and costs of different technologies. Others, with established nuclear power programmes, need information on maintaining operational effectiveness and on technological developments in line with the best international experience.

The cornerstone of the IAEA Nuclear Energy Series, this publication describes the rationale and vision for the peaceful uses of nuclear energy. It 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 holistic approach to the use of nuclear energy and to be equally applicable to all elements of nuclear energy systems, including human resources and technical, management and economic aspects, with due regard to the protection of people and the environment, security, and non-proliferation. As such, it represents the foundation for all other publications within the series.

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# 1. BASIC PRINCIPLES OF NUCLEAR ENERGY

## 1.1. RATIONALE AND VISION FOR THE PEACEFUL USES OF NUCLEAR ENERGY

Nuclear energy has the potential to be a reliable, sustainable and environmentally friendly energy source that can contribute to the accessibility of affordable energy services in all interested countries for present and future generations. *Any use of nuclear energy should be* ***beneficial, responsible and sustainable,*** *with due regard to the protection of people and the environment, non-proliferation, and security.*

# 2. OVERVIEW OF THE BASIC PRINCIPLES

## 2.1. 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.

## 2.2. 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 the IAEA Safety Standards and other internationally recognized standards.

**Security.** The use of nuclear energy should take due account of the risk of the 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.

### 2.3. 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.

## 3. DESCRIPTION OF THE BASIC PRINCIPLES

In this section, each basic principle is described and the related recommendations for nuclear energy systems are expressed.

### 3.1. PRINCIPLE 1 — BENEFITS

*The use of nuclear energy should provide benefits that outweigh the associated costs and risks.*

Access to reliable, affordable and clean energy services is essential to support economic development and an improved standard of living for the world's population while reducing pressure on the environment. Nuclear energy systems, when implemented, should provide benefits that outweigh the associated costs and risks.

There are different types of benefits, costs and risks (e.g. economic, environmental and proliferation related) associated with different energy systems that produce comparable energy products and with the techniques for the use of these energy products. The benefits, costs and risks may be distributed unevenly among the affected population (including future generations). Any particular benefit, cost or risk could be valued dissimilarly by different members of an affected population. There are also disparities in the political and regulatory processes by which States and multi-State organizations make trade-offs among largely incomparable benefits, costs and risks and in how they appraise the diverse preferences of their differently affected citizens.

All of these issues should be taken into account in assessing the benefits of a nuclear energy system.

## 3.2. PRINCIPLE 2 — TRANSPARENCY

*The use of nuclear energy should be based on open and transparent communication of all its facets.*

Since its inception, both the benefits and risks arising from the use of nuclear energy have generated public interest, concern and debate.

Transparency regarding the development and use of nuclear energy systems is critically important in order to develop and maintain the trust of stakeholders that nuclear energy organizations are behaving in an ethical and socially responsible manner. Trust is very difficult to earn and very easy to lose. The stakeholders involve a broad spectrum of people ranging from the local community to people in neighbouring countries as well as the international community. It also includes regulatory organizations and financial institutions. In providing transparent information, due regard needs to be taken concerning commercial and security considerations.

Information on the risks and benefits of nuclear energy systems must be clear and open. This is also the case for information on operational experience and events during the operation of these nuclear energy systems.

## 3.3. PRINCIPLE 3 — PROTECTION OF PEOPLE AND THE ENVIRONMENT

*The use of nuclear energy should be such that people and the environment are protected in compliance with the IAEA safety standards and other internationally recognized standards.*

The IAEA Safety Standards (e.g. IAEA Safety Standards Series No. SF-1, Fundamental Safety Principles [1]) reflect an international consensus on what constitutes a high level of safety for protecting people and the environment from the harmful effects of ionizing radiation and provide guidance and recommendations to achieve the desired level. These standards and their application, in particular peer reviews and advisory services, both at the national and international levels, are essential components that support the harmonized implementation of other international instruments such as the Convention on Nuclear Safety.

All phases in the use of nuclear energy (uranium extraction, energy generation, waste management, etc.) involve certain risks. The risks include conventional (e.g. occupational, transport and fire) and radiation risks for people, as well as risks associated with the environmental impact of any activity

related to the development or use of nuclear energy. All risks should be carefully identified and assessed prior to the start of the activities and throughout their entire lifetimes, and protective measures should be taken to ensure compliance with internationally recognized standards. A high level of safety is achieved through technological development and engineering solutions, effective management systems, human performance, knowledge management and regulatory systems.

The environmental consequences should be measured according to the internationally accepted environmental impact assessment procedures, including appropriate public hearings and transboundary considerations.

Industrial safety is addressed in a number of international and national standards.

Technological solutions and operational measures should be implemented during the entire life cycle of nuclear facilities in accordance with the relevant standards.

The further development of technology and engineering solutions contributes to continually enhancing the achieved level of safety.

### 3.4. PRINCIPLE 4 — SECURITY

*The use of nuclear energy should take due account of the risk of the malicious use of nuclear and other radioactive material.*

The nuclear security regime comprises international binding and non-binding legal instruments together with the IAEA's nuclear security guidance issued in the IAEA Nuclear Security Series of publications. Approaches to physical protection against theft or unauthorized diversion of nuclear material and against the sabotage of nuclear facilities are established in INFCIRC/225/Rev.4 [2], which states that:

> "Secure nuclear energy facilities, material and operations against malevolent acts, including sabotage, theft and malicious misuse, requires a legal framework, regulatory capability and enforcement authority sufficient to prevent, detect and respond to theft, sabotage, unauthorized access, illegal transfer or other malevolent acts."

## 3.5. PRINCIPLE 5 — NON-PROLIFERATION

*The use of nuclear energy should take due account of the risk of the proliferation of nuclear weapons.*

Nuclear energy systems should continue to be developed and used in such a way that, based on intrinsic features and extrinsic measures, they remain an unattractive means to acquire fissile material for a nuclear weapons programme. The diversion of nuclear material and the misuse of nuclear energy systems and technology for the production of fissile material for a nuclear weapons programme should be reasonably difficult and detectable. An IAEA publication, Guidance for the Application of an Assessment Methodology for Innovative Nuclear Energy Systems [3], describes fundamentals that should apply to consideration of the proliferation resistance of future nuclear energy systems.

## 3.6. PRINCIPLE 6 — LONG TERM COMMITMENT

*The use of nuclear energy should be based on a long term commitment.*

Since the use of nuclear energy systems entails attention to many complex and interrelated issues over a long period of time, the use of them in a State or region should be based on a long term and stable programme in order to maximize the benefit coming from its use as well as to fulfil the responsibility associated with the use by the State or by the owner/operator of the nuclear facilities.

The commitment includes the acceptance of the relevant international instruments and legal requirements (agreements, protocols, conventions, etc.) as described in the IAEA's Handbook on Nuclear Law [4].

Long term commitment also includes a long term programme covering the decommissioning of nuclear facilities, spent fuel and waste management, and reclamation of mines and other nuclear facilities that have a potential to cause environmental hazard.

## 3.7. PRINCIPLE 7 — RESOURCE EFFICIENCY

*The use of nuclear energy should be efficient in using resources.*

Natural resources are consumed during the construction, operation and decommissioning of nuclear power plants and fuel cycle facilities.

Efficient design and management should be adopted to reduce the amount of non-renewable material required to produce the desired energy product. The essential principles of waste minimization should be followed taking into account social and economic factors, i.e. to reduce, reuse and recycle.

Many components used throughout the nuclear energy chain can be reused and recycled, ranging from site locations and plant equipment to fuel (uranium, thorium and plutonium) and construction materials. Renewable resources should also be efficiently adopted, taking into account that some of these materials may require significant time for their regeneration.

The use of renewable resources and materials that have limited use outside of nuclear energy applications should be preferred when possible.

Knowledge of nuclear technology also has to be considered and managed as a resource and be assessed, preserved, used and enlarged.

## 3.8. PRINCIPLE 8 — 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.*

As with any use of technologies, it is important to strive for continual improvement by taking advantage of feedback from experience and technological innovation with the aim of enhancing safety, security, economics, proliferation resistance, and protection of the environment.

Concerted international efforts based on shared vision, goals and experience are encouraged for efficient and successful improvement and innovation.

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**Meetings of the Standing Advisory Group on Nuclear Energy (SAGNE)**

Vienna, Austria: 18–20 April 2007, 30 October–2 November 2007, 9–11 April 2008

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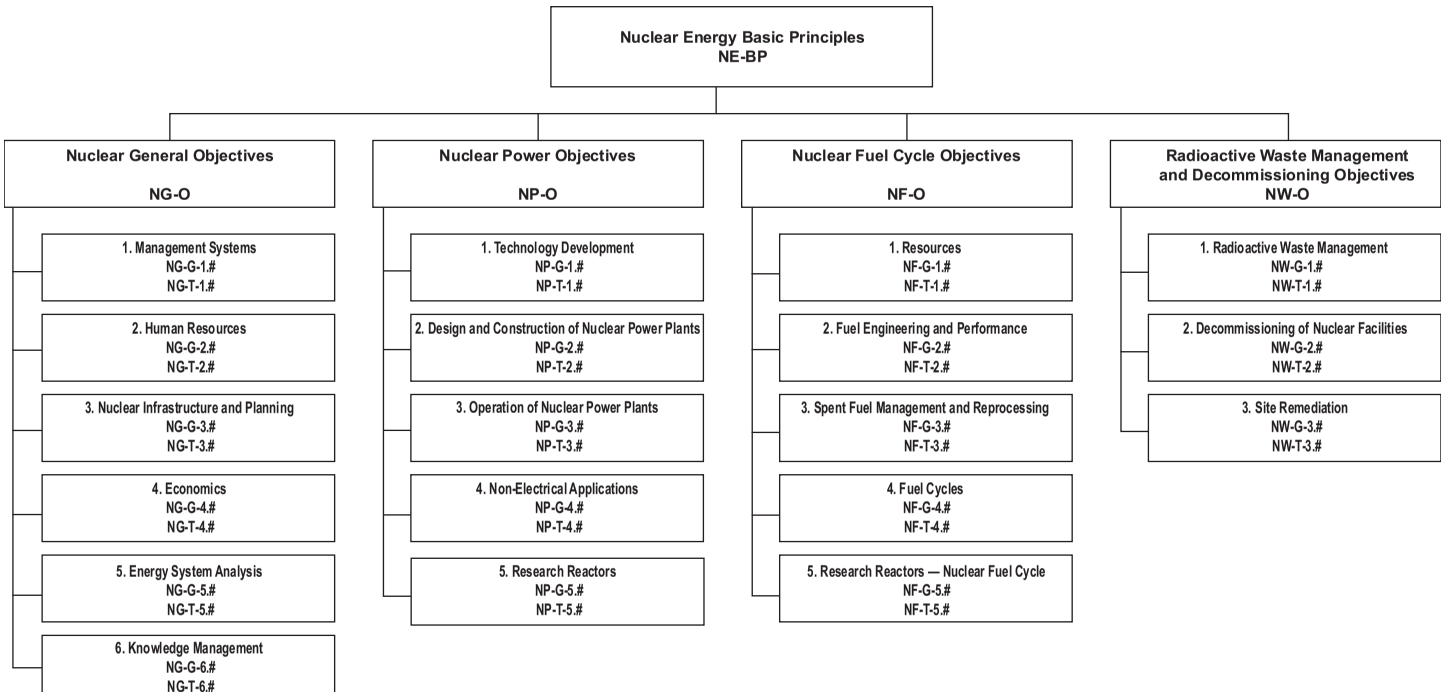


*Key*

**BP:** Basic Principles
**O:** Objectives
**G:** Guides
**T:** Technical Reports
**Nos. 1-6:** Topic designations
**#:** Guide or Report number (1, 2, 3, 4, etc.)

*Examples*

**NG-G-3.1:** Nuclear General (**NG**), **G**uide, Nuclear Infrastructure and Planning (topic **3**), **#1**
**NP-T-5.4:** Nuclear Power (**NP**), Report (**T**), Research Reactors (topic **5**), **#4**
**NF-T-3.6:** Nuclear Fuel (**NF**), Report (**T**), Spent Fuel Management and Reprocessing, **#6**
**NW-G-1.1:** Radioactive Waste Management and Decommissioning (**NW**), **G**uide, Radioactive Waste (topic **1**), **#1**

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INTERNATIONAL ATOMIC ENERGY AGENCY
VIENNA
ISBN 978–92–0–112608–5
ISSN 1995–7807