International Atomic Energy Agency

# Revision of IAEA Safety Requirements for Research Reactors, SSR-3

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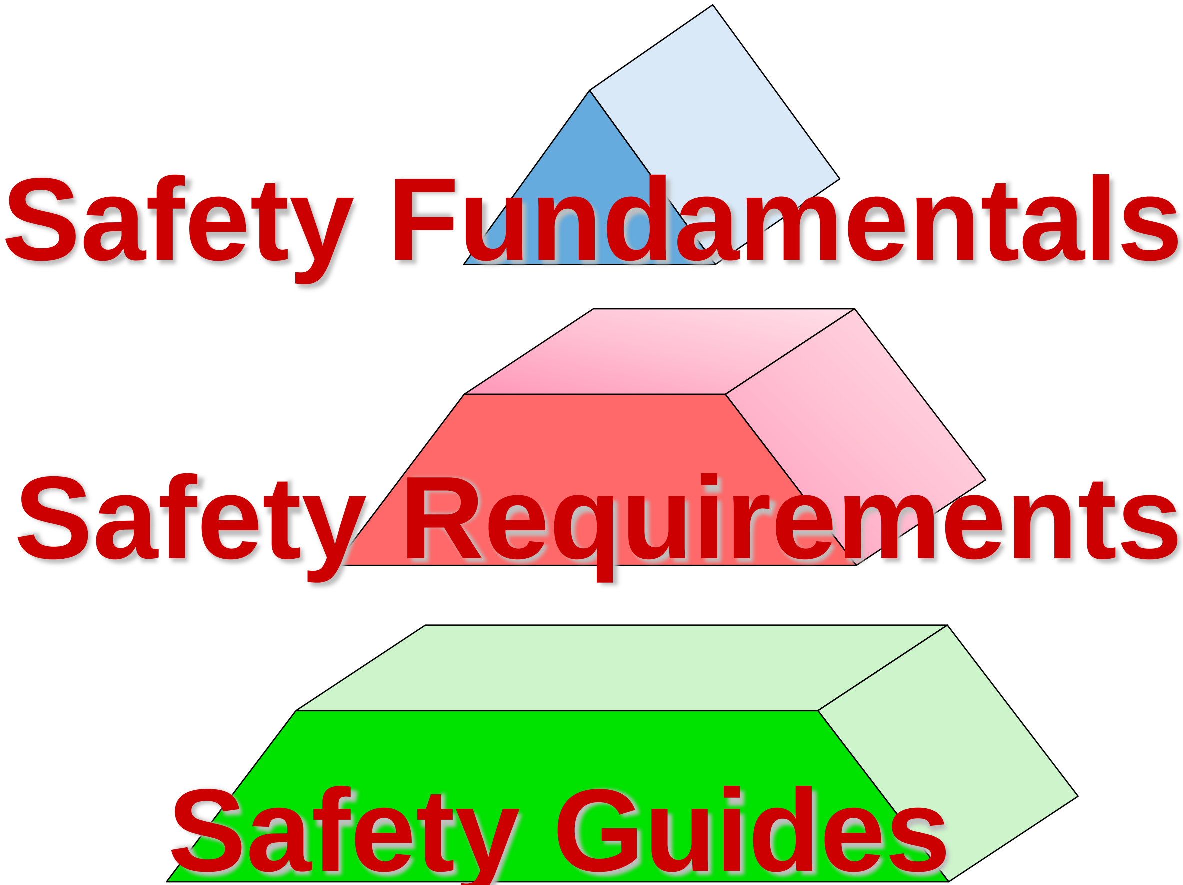
# IAEA Safety Standards for Research Reactors

## The IAEA Safety Standards for RRs reflect international consensus on what constitutes a high level of safety, and:

- Serve as the basis for IAEA safety review services and assistance;
- Cover all areas important to the safety of RRs;
- Provide guidance for effective implementation of the “Code of Conduct on the Safety of Research Reactors”;
- Should be used by all organizations involved in RRs, including the operating organization, regulatory body, users, designers and vendors;
- Use regulatory language to facilitate their incorporation into national safety regulations and guides

# IAEA Safety Standards Series Hierarchy



# IAEA Safety Standards for Research Reactors

IAEA Safety Standards
for protecting people and the environment

Fundamental Safety Principles

Jointly sponsored by
Euratom FAO IAEA ILO IMO OECD/NEA PAHO UNEP WHO

Safety Fundamentals
No. SF-1

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Safety of Research Reactors

Safety Requirements
No. NS-R-4

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Ageing Management for Research Reactors

Specific Safety Guide
No. SSG-10

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Safety Assessment for Research Reactors and Preparation of the Safety Analysis Report

Specific Safety Guide
No. SSG-20

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Use of a Graded Approach in the Application of the Safety Requirements for Research Reactors

Specific Safety Guide
No. SSG-22

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Safety in the Utilization and Modification of Research Reactors

Specific Safety Guide
No. SSG-24

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IAEA SAFETY STANDARDS SERIES

Decommissioning of Nuclear Power Plants and Research Reactors

SAFETY GUIDE

IAEA Safety Standards
for protecting people and the environment

Instrumentation and Control Systems and Software Important to Safety for Research Reactors

Specific Safety Guide
No. SSG-37

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# Revision of NS-R-4

**The revision of the documents was initiated by:**

- **The long term structure of IAEA Safety Standards approved by the Member States in 2008.**
- **The need to ensure coherency and consistency with the other relevant IAEA Safety Standards (e.g. SF-1 and GSRs), which include aspects that were not originally covered, as well as coherency with the recently published NPPs documents SSR-2/1 and SSR-2/2.**
- **The need to incorporate experience from MSs and IAEA on application of the document, as well as the operating experience feedback from the IAEA Incident reporting systems and feedback from the Fukushima Daiichi accident.**

# Revision of NS-R-4

- **Development status/process:**
  - **The DPP was approved by CSS in April 2014;**
  - **The first draft was developed in two CSMs during 2014 and it was reviewed following the IAEA internal QA process;**
  - **Approved by the Committees in November 2014;**
  - **Issued for 120d Member State review in January 2015. MS comments resolved and incorporated July 2015;**
  - **Approved by RASSC, WASSC, TRANSAC, and NUSSC meeting in November-December 2015;**
  - **Endorsed by the CSS for approval in April 2016;**
  - **Approved by BoG in June 2016; publication in process.**

# Revision of NS-R-4

- The scope of the NS-R-4 remains essentially unchanged. However:
  - Sub-critical assemblies are covered;
  - A Section on “Preparation for Decommissioning” replaced “Decommissioning”;
  - Interfaces between safety and security are covered.
- Coherency and consistency of the technical contents with the other relevant IAEA Safety Standards (e.g. SF-1 and GSRs) ensured, including topics not originally covered. Feedback from the use of the document incorporated.
- Material on “regulatory supervision”, “siting”, and “management system” was revised in accordance with the Committees and Commission decision.
- Material that is more suitable to guidance has been removed.
- References updated.

The Fukushima Daiichi Accident
Report by the Director General and Technical Volumes

# Revision of NS-R-4

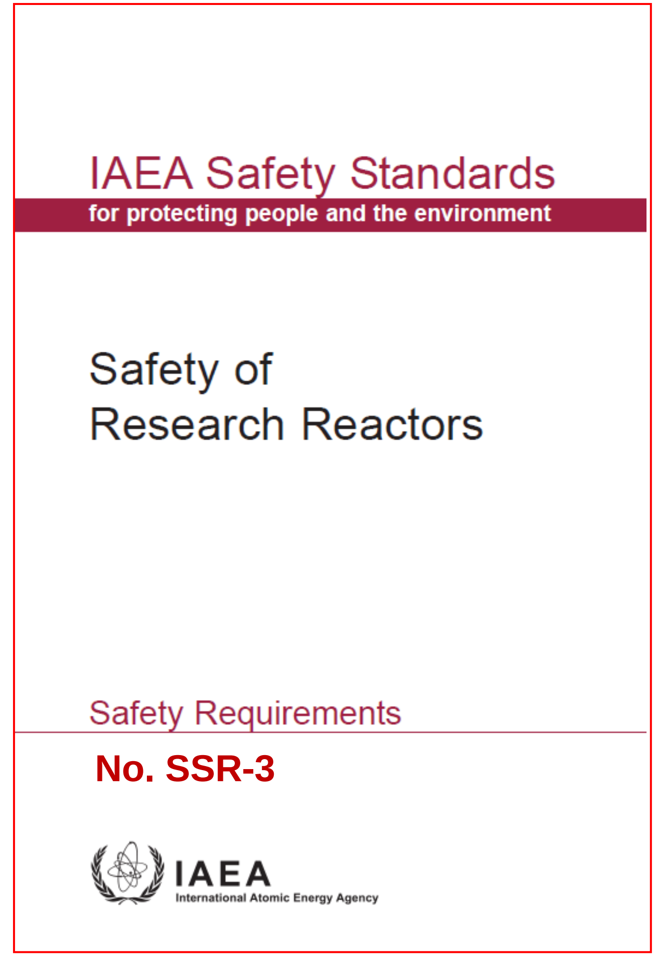
**Relevant feedback from the accident at the Fukushima-Daiichi NPP is covered in the revised version, including:**

- **Analysis of extreme external events including their combination and consequential events, including complete loss of electrical power supply;**
- **Design extension conditions;**
- **Application of defence in depth (independence of levels, common cause failure, …);**
- **Design and operation of experimental facilities;**
- **Emergency preparedness in particular for research reactors with potential core damage (melting) and off-site consequences;**
- **Training and retraining of personnel;**
- **Other relevant feedback (e.g. on siting, regulatory effectiveness, management systems) are covered by the relevant General Safety Requirements documents and referred to in the revised version of NS-R-4.**

# Structure of SSR-3

1. Introduction
2. Applying safety objectives, concepts and principles
3. Regulatory supervision
4. Management for safety and verification of safety
5. Site evaluation
6. Design
7. Operation
8. Preparation for Decommissioning
9. Interface between Safety and Security

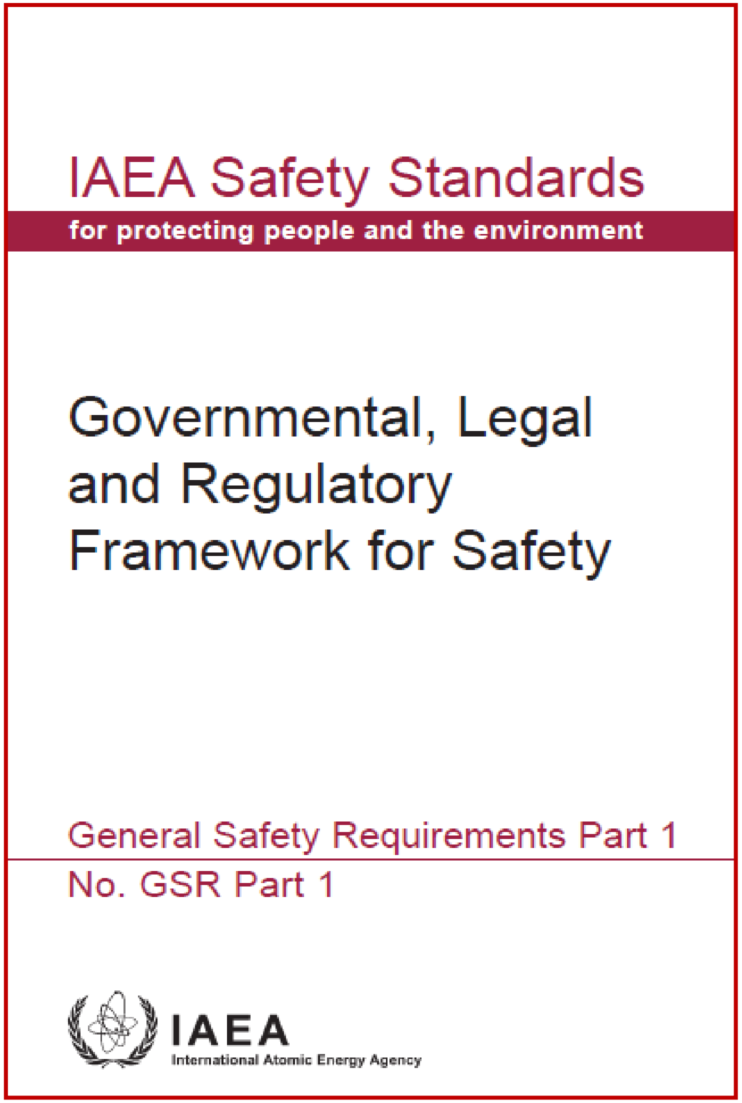
- Appendices and Annexes.




RRs with power levels in excess of several tens of megawatts, fast reactors, and RRs using an experimental device such as a high-pressure and temperature loop or a cold neutron source may require application of supplementary measures or even the application of requirements (and engineering standards) for power reactors and/or additional safety measures.

# Regulatory Supervision

- The requirements established by the IAEA safety standard GSR Part 1 apply to research reactors.
- In SSR-3, emphasis is placed on:
  - **Authorization process;**
  - **Preparation and review of the Safety Analysis Report (R1);**
  - **Regulatory inspection programmes for monitoring compliance and enforcement.**


IAEA Safety Standards
for protecting people and the environment

Governmental, Legal and Regulatory Framework for Safety

General Safety Requirements Part 1
No. GSR Part 1

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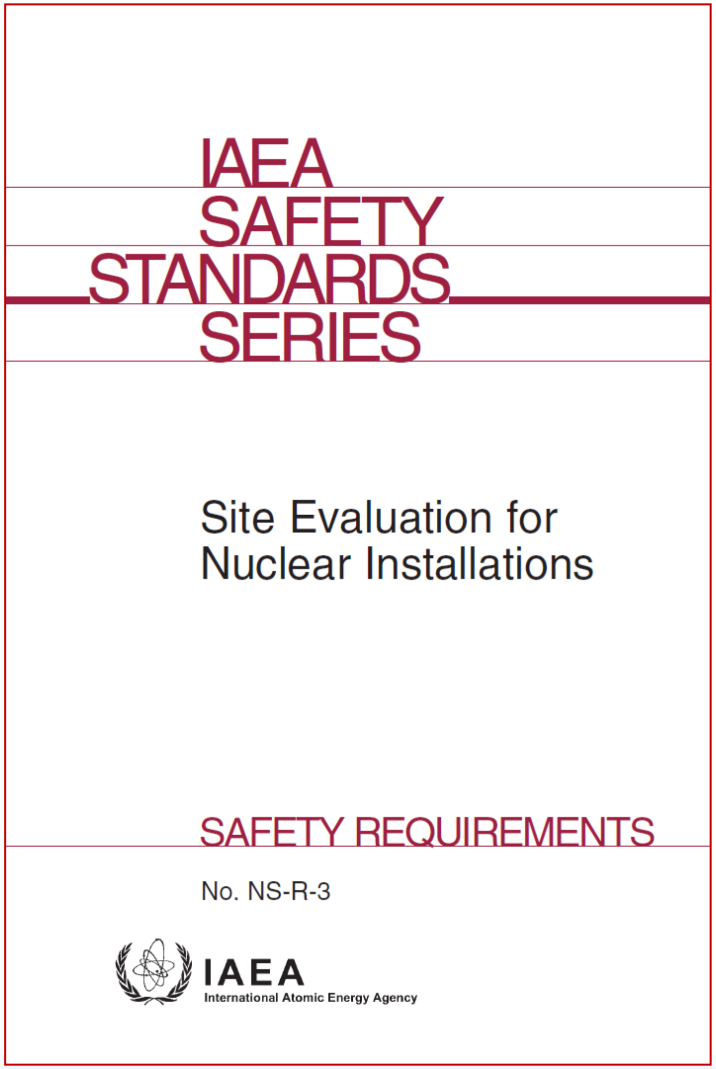
# Management for Safety and Verification of Safety

- Responsibilities in the Management for Safety (R2);
- Safety Policy (R3);
- Integrated Management System (R4);
- Verification of Safety:
  - Safety Assessment; (R5)
  - Periodic Safety Reviews;
  - Safety Committees (R6).

# Site Evaluation

- The safety requirements established by the IAEA safety standard NS-R-3 apply to research reactors.

- SSR-3 establishes specific requirements related to site evaluation for research reactors.



# Design: Principal Technical Requirements

**Requirement 7: Main safety functions**

**Requirement 8: Radiation protection**

**Requirement 9: Design for a research reactor facility**

**Requirement 10: Application of the concept of defence in depth for a research reactor**

**The design of a research reactor shall apply the concept of defence in depth. The levels of defence in depth shall be independent as far as is practicable.**

6.13. The defence in depth concept (see paras 2.10-2.14) shall be applied to provide several levels of defence . . . . etc.

6.14. The design:

(a) Shall provide for successive verifiable physical barriers to the release of radioactive material . . . . etc.

**Requirement 11: Interfaces of safety with security and State system of accounting for, and control of, nuclear material**

**Requirement 12: Use of a graded approach**

# General Requirements for Design: (1/2)

- **Safety Classification of SSCs: According to their safety functions and safety significance;**
- **Design Basis: Design for operational states and accident conditions;**
- **Postulated Initiating Events (PIE): all foreseeable events with potential for serious consequences and with significant frequency of occurrence;**
- **Internal and External Hazards: both individually and in credible combinations;**
- **Design Basis Accidents: derived from PIEs;**
- **Design Limits: for all operating states and for accident conditions;**
- **Design Extension Conditions: without significant fuel degradation and with core melt;**
- **Combination of events and failures: Engineered safety features; Reliability; Single failure; Common cause failure; Physical separation; Fail-safe design; Qualification, ease of testing and maintenance;**



**SSCs: Structures, systems and components**

# Requirement 22: Design extension conditions for a research reactor

**A set of design extension conditions for a research reactor shall be derived for the purpose of enhancing the safety of the research reactor by enhancing its capabilities to withstand, without unacceptable radiological consequences, accidents that are either more severe than design basis accidents or that involve additional failures. The set of design extension conditions shall be derived on the basis of engineering judgement and by using a graded approach, deterministic assessments and complementary probabilistic assessments, as appropriate. The design extension conditions shall be used to identify the additional accident scenarios to be addressed in the design and to plan practicable provisions for the prevention of such accidents or mitigation of their consequences if they do occur.**

## NS-R-4 (2005)

| Operational states | | Accident conditions | | | |
|---|---|---|---|---|---|
| NO | AOO | (a) | DBAs | Beyond design basis accidents | |
| | | | | (b) | Severe Accidents |
| Included in the design basis | | | | Accident management | |

## Draft SSR-3 (2016), facility states

| Operational states | | Accident conditions | | |
|---|---|---|---|---|
| NO | AOO | DBAs | Design Extension Conditions | |
| Design Basis | | | Without significant fuel degradation | With core melt |
| | | | Mitigation, EPR and accident management | |

# General Requirements for Design (continued): (2/2)

- Commissioning;
- Calibration, testing, maintenance, inspection;
- Emergency Preparedness and Response;
- Decommissioning;
- Radiation protection;
- Optimal operator performance;
- Provisions for safe utilization and modification;
- Ageing management;
- Provisions for long shutdown periods;
- Unauthorized access;
- Prevention of disruptive or adverse interactions;
- Safety analysis.

# Specific Design Requirements: (1/2)

- Building and structures;
- Means of confinement;
- Reactor core and fuel design;
- Provision of reactivity control;
- Reactor shutdown systems;
- Reactor coolant and related systems;
- Emergency cooling of the reactor core

# Specific Design Requirements (continued): (2/2)

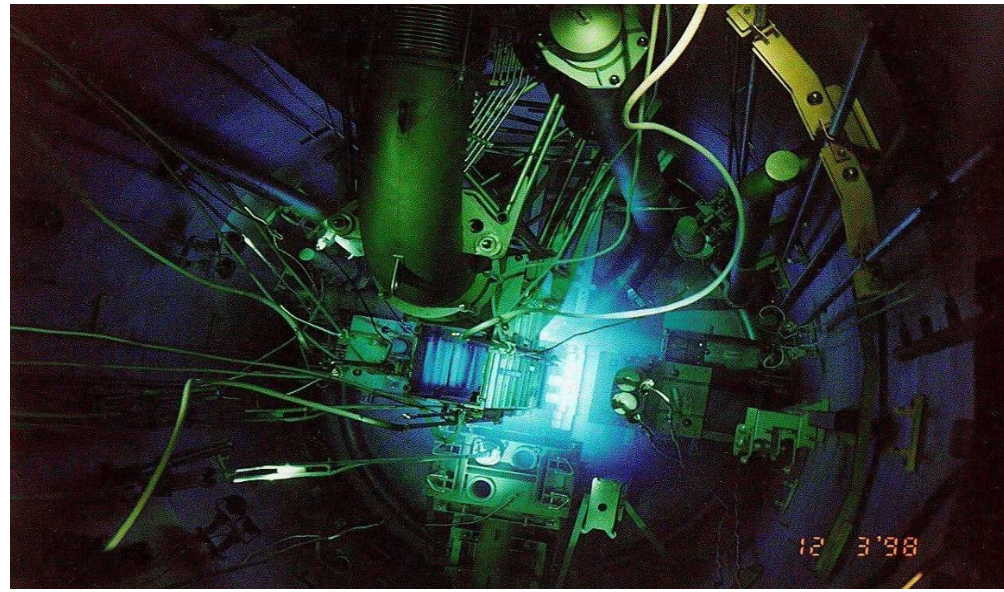
- **Instrumentation and control systems (4 Rs):**
  - Provision of I&C systems; Reactor protection system; Reliability and testability; Use of computer based equipment and systems
- **Control room, and Supplementary control room;**
- **Emergency response facilities on the site**
- **Electrical power supply;**
- **Radiation protection systems;**
- **Handling and storage system for fuel and components;**
- **Radioactive waste systems;**
- **Supporting and auxiliary systems:**
  - Performance; Fire protection; Lighting; Air conditioning; Compressed air; experimental devices.

# Operation (1/2)

- **Responsibilities of the operating organization;**
- **Structure and function;**
- **Operating personnel;**
- **Training, retraining and qualification of personnel;**
- **Operational limits and conditions;**
- **Performance of safety related activities;**
- **Commissioning programme;**
- **Operating procedures;**
- **Main control room, supplementary control room and equipment;**
- **Material conditions and housekeeping;**
- **Maintenance, periodic testing and inspection;**

# Operation (2/2)

- **Core management and fuel handling;**
- **Fire safety;**
- **Non-radiation-related safety;**
- **Emergency preparedness;**
- **Records and reports;**
- **Utilization and modification;**
- **Radiation protection;**
- **Management of radioactive waste;**
- **Ageing management - Periodic safety review;**
- **Extended shutdown;**
- **Feedback of operating experience.**



# Preparation for Decommissioning

- The operating organization shall prepare a decommissioning plan and shall maintain it throughout the lifetime of the research reactor;
- The decommissioning plan shall be updated in accordance with changes in regulatory requirements, modifications to SSCs, advances in technology;
- The operating organization shall be responsible for the preservation of knowledge of the reactor facility and for the retention of key personnel to facilitate decommissioning.

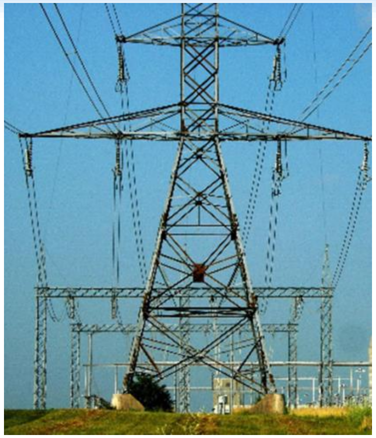
# Interface between Safety and Security

- Shall be addressed in an integrated manner throughout the lifetime of the reactor;

- Safety measures and security measures shall be established and implemented in such a manner that they do not compromise one another;

- General safety requirements on the interface between safety and security established in GSR Part 1 and GSR Part 2 apply to research reactors with the appropriate use of a graded approach.

# Appendices and Annexes



- **Appendices:**
  - ➢ **Selected postulated initiating events.**
  - ➢ **Operational aspects warranting particular consideration**

- **Annexes:**
  - ➢ **Selected safety functions;**
  - ➢ **Overview of the application of safety requirements to subcritical assemblies.**

# IAEA Safety Standards and Supporting Publications for RRs Available Online

- **IAEA Safety Standards homepage:**
  http://www-ns.iaea.org/standards/default.asp?s=11&l=90

- **IAEA Safety Standards for RRs:**
  http://www-ns.iaea.org/standards/documents/default.asp?s=11&l=90&sub=20&vw=9#sf

- **IAEA Safety Report Series:**
  http://www-pub.iaea.org/books/IAEABooks/Series/73/Safety-Reports-Series

- **IAEA TECDOCs:**
  http://www-pub.iaea.org/books/IAEABooks/Series/34/Technical-Documents

# Concluding Remarks

- Application of the IAEA Safety Standards will help Member States to achieve the highest level of safety for RRs.
- The IAEA programme on the safety of RRs gives priority to the development and promotion of proper use of the IAEA Safety Standards through:
  - Providing assistance to Member States in application of the IAEA Safety Standards;
  - Conducting safety review missions based on the IAEA Safety Standards;
  - Implementing workshop and other training activities based on the IAEA Safety Standards.

# *Thank you for your attention !*