



IAEA

60 Years

Atoms for Peace and Development

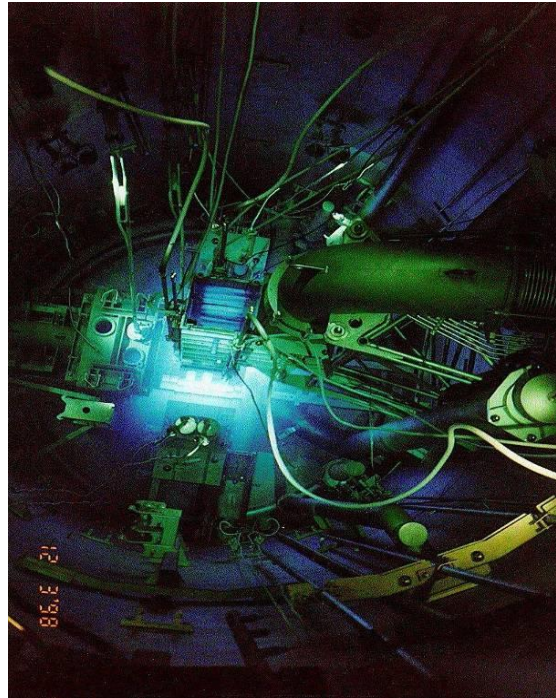
IAEA Activities on Safety of Research Reactors

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Division of Nuclear Installation Safety

**IAEA Workshop on Safety Reassessment of Research Reactors in Light of the Lessons
Learned from the Fukushima Daiichi Accident (J7-TR-54790)**
and 18th IGORR Conference
Sydney, 4-7 December 2017

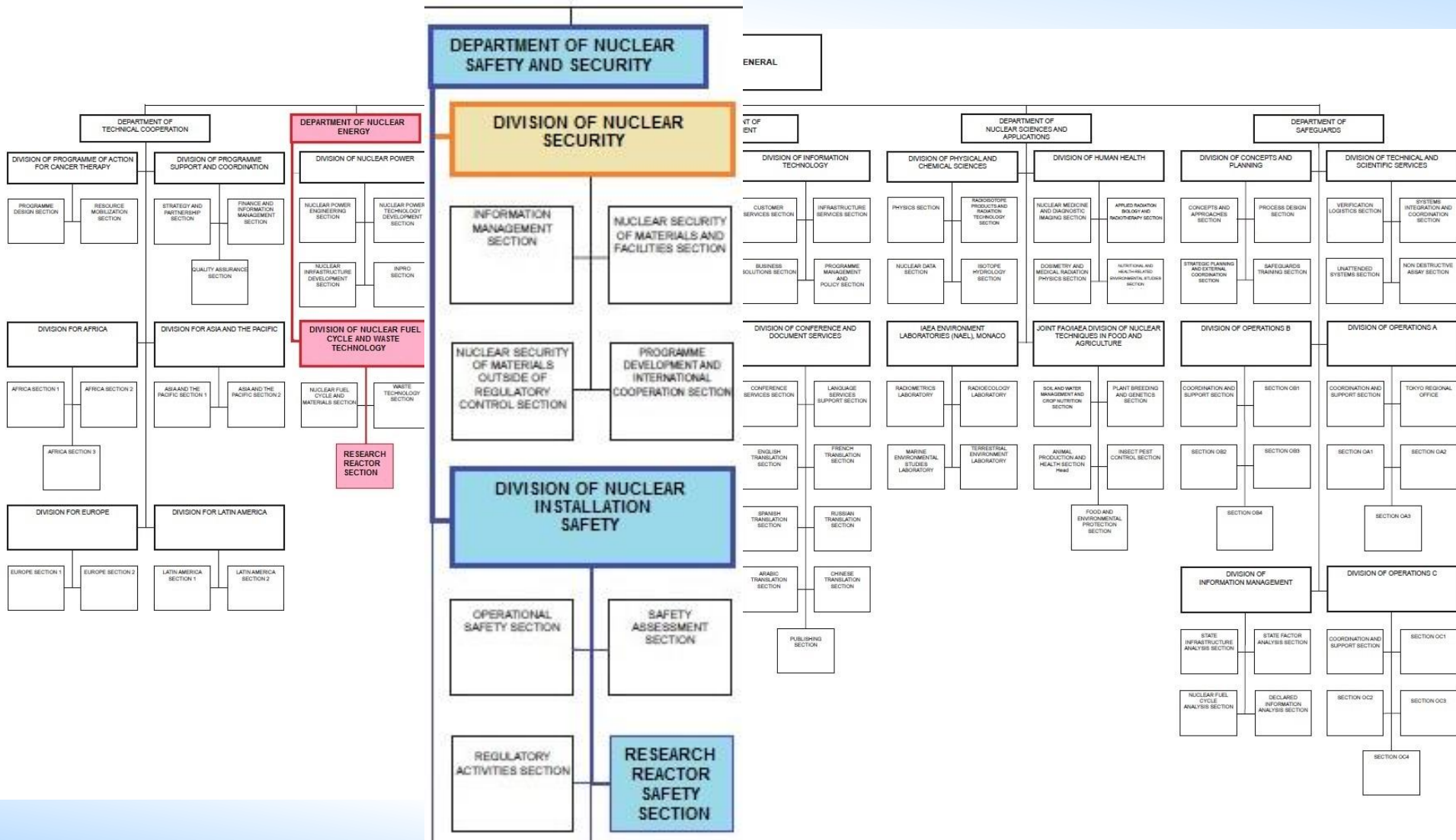
- Introduction
- Overview of research reactors
- Safety issues and challenges
- Updating IAEA activities on research reactor safety
 - Feedback from activities on safety reassessments following FD
- Concluding remarks – Focus 2018/2019

Introduction: Enhancing Safety of Research Reactors



To support Member States in achieving and maintaining a high level of safety of research reactors using peer reviews and advisory services based on IAEA safety standards

RRSS/NSNI – IAEA Department of Nuclear Safety and Security



Overview of Research Reactors (IAEA/RRDB)

Built to date: about 770

Operational 218

Temp. shutdown 22

Shutdown+extended shutdown 136

Under decom. 16*

Decommissioned 356

**Recently introduced category.*

Under construction/planned:

Argentina, Azerbaijan, Belgium, Brazil, France, Korea, Netherlands, Nigeria, Russian Federation, Saudi Arabia, Sudan, Tanzania, Tunisia, Ukraine, United States of America, Vietnam.

Information taken from the IAEA Research Reactor Database (RRDB)

<https://nucleus.iaea.org/RRDB/RR/>



Region	Operational Research Reactors
Africa	6
Americas	66
Asia/Pacific	41
Europe	105

Issue and challenges – Updating the IAEA activities on research reactors

The IAEA programme and activities are updated based on the issues and challenges are identified .

- Main sources of information:
 - Feedback from Code of Conduct meetings, and technical meetings;
 - Feedback from the IAEA incident reporting systems: IRSRR;
 - Feedback from IAEA safety reviews.



CODE OF CONDUCT MEETING: PERCENTAGE OF IMPLEMENTATION (2011, 2014 AND 2017, FOR 24 COMMON MS)



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■ Level 0: Not implemented ■ Level 1: Incomplete

■ Level 2: Partially implemented

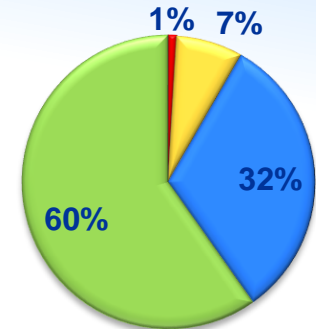
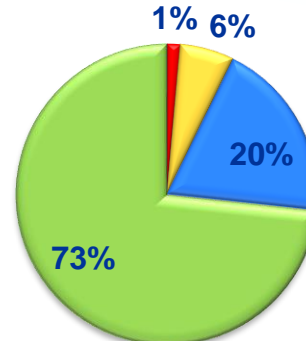
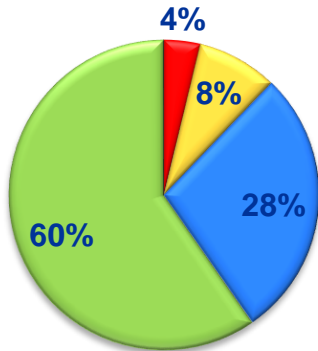
■ Level 3: Fully implemented

Role of the State

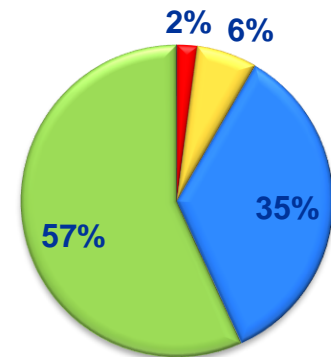
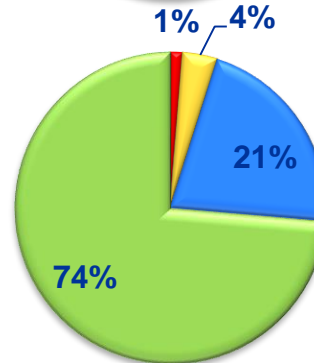
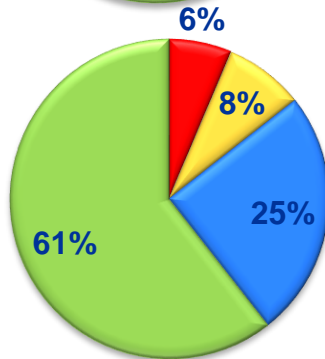
Role of the Regulatory Body

Role of the Operating Organization

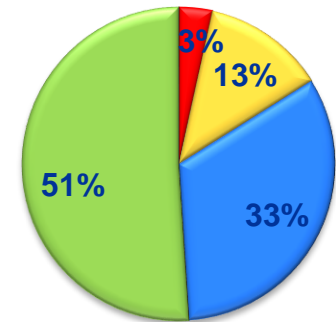
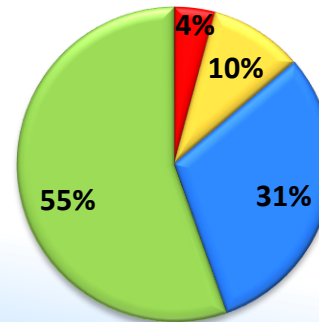
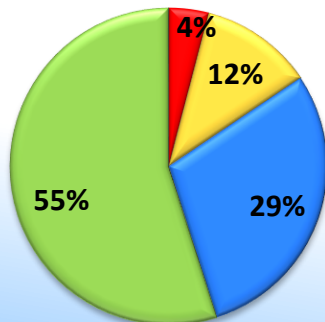
2017



2014

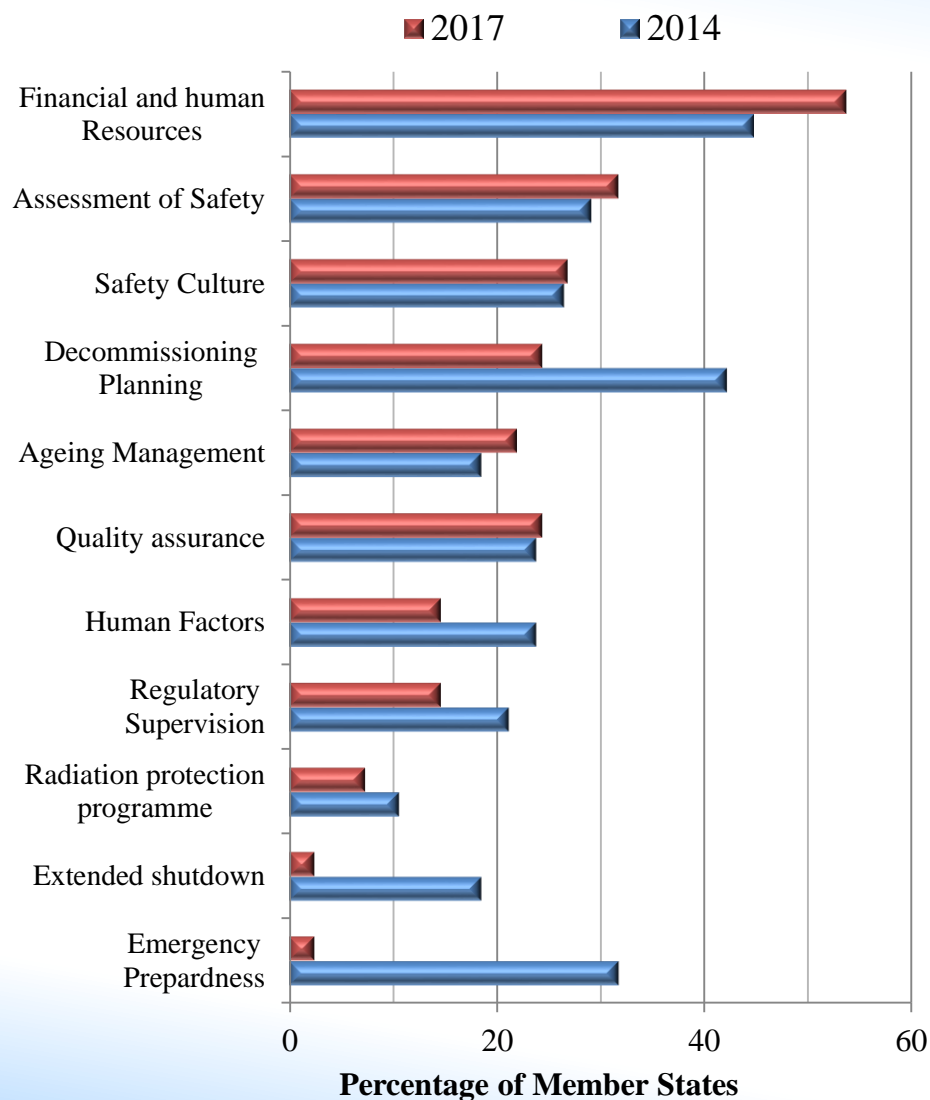


2011



Issue and challenges:

Code of Conduct Meeting - Safety Areas Needing Improvement (2014-2017)



- Financial and human resources continues to be the main area of concern, now over 50%.
- Safety assessment, in the areas of periodic safety review and extreme external events, continues to need improvement.
- Safety culture, decommissioning planning and ageing management remain prominent concerns.
- Enhancements in regulatory supervision were reported during 2011-2017, but continued improvements are needed.

Issue and challenges:

Feedback from Incidents reported to IRSRR

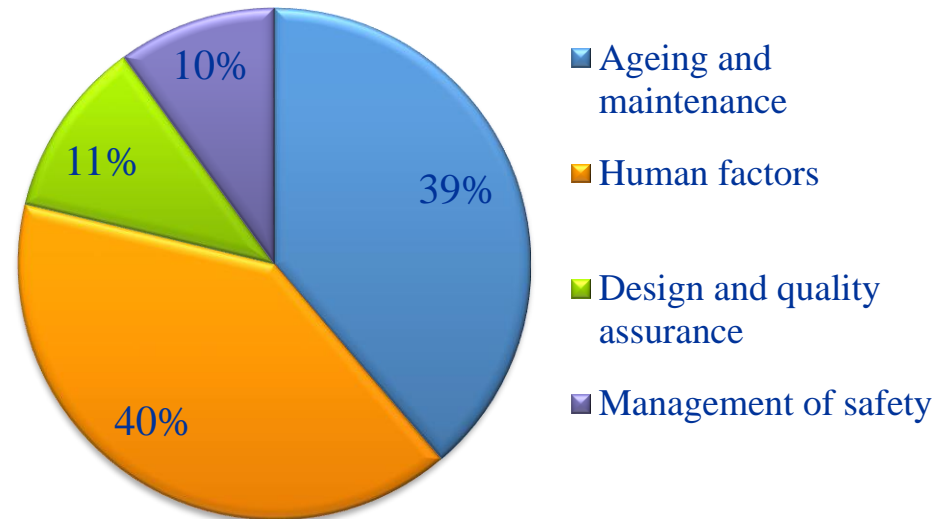
Human errors/factors:

- Lack of adequate training/retraining;
- Ineffective use of procedures;
- Inadequate consideration of human factors in operating procedures, including planning of the work.

Ageing and maintenance:

- Inadequate actions to minimize ageing degradation (e.g. proper water chemistry programme);
- Inadequate activities for detecting ageing degradation (periodic tests, inspections, observations during walkthrough);
- Inadequate maintenance programme.

Causes of Events Reported to the IRSRR



-
- The collage features several images:
 - Top left: A group of people in a control room or meeting, with one person in a red shirt looking at a laptop.
 - Top right: A group of people in suits sitting around a long table in a formal meeting.
 - Center: The text 'NUCLEAR SAFETY REVIEW 2017' in large, bold, black capital letters.
 - Below center: Three people wearing white hard hats and safety vests, looking at a screen or equipment.
 - Bottom left: A close-up of a person wearing a blue protective suit and a mask, working in a laboratory or industrial setting.
 - Bottom right: A person in a white protective suit and mask working with equipment in a laboratory or industrial setting.

RRSS activities – Safety Standards and supporting documents

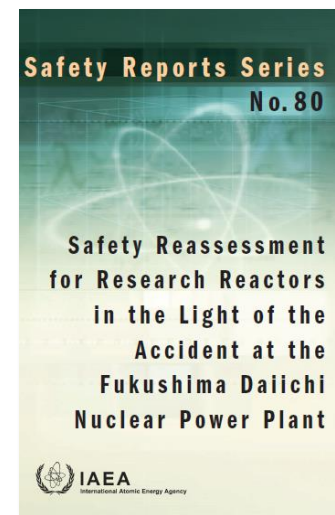
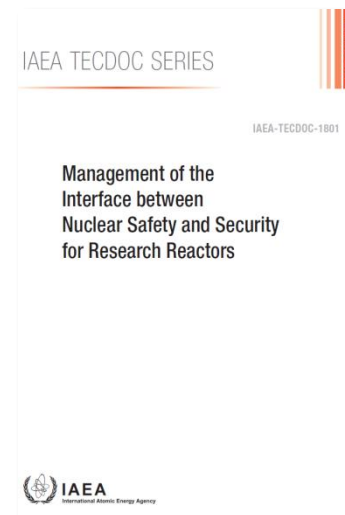
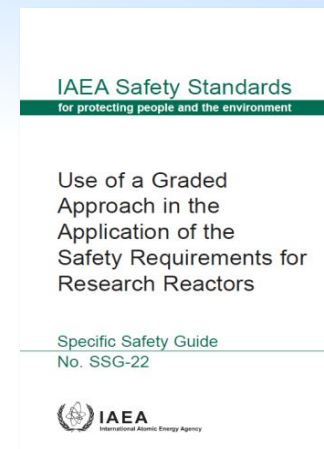
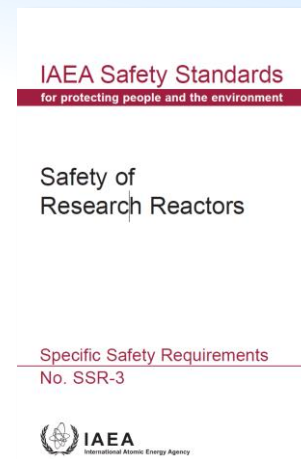
- Development of safety standards and supporting documents and assisting Member States in their application.
- IAEA Safety Standards No. SSR-3, Safety of Research Reactors, was issued in 2016 (superseded NS-R-4).

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

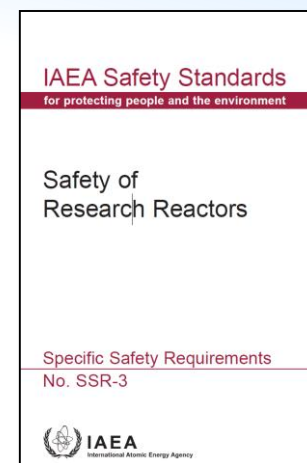
Safety Standards are now accessible through the Nuclear Safety and Security Online User Interface, or NSS-OUI: <https://nucleus-apps.iaea.org/nss-oui>







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

Safety Reports: <http://www-pub.iaea.org/books/IAEABooks/Series/73/Safety-Reports-Series>



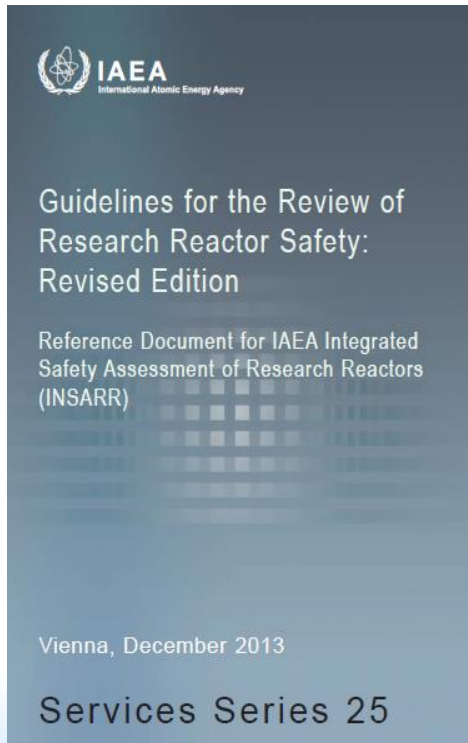
Safety Standards...



IAEA Safety Standards for protecting people and the environment	IAEA Safety Standards for protecting people and the environment	IAEA Safety Standards for protecting people and the environment	IAEA Safety Standards for protecting people and the environment	IAEA Safety Standards for protecting people and the environment	IAEA Safety Standards for protecting people and the environment
Commissioning of Research Reactors	Maintenance, Periodic Testing and Inspection of Research Reactors	Core Management and Fuel Handling for Research Reactors	Operational Limits and Conditions and Operating Procedures for Research Reactors	The Operating Organization and the Recruitment, Training and Qualification of Personnel for Research Reactors	Radiation Protection and Radioactive Waste Management in the Design and Operation of Research Reactors
Safety Guide No. NS-G-4.1	Safety Guide No. NS-G-4.2	Safety Guide No. NS-G-4.3	Safety Guide No. NS-G-4.4	Safety Guide No. NS-G-4.5	Safety Guide No. NS-G-4.6
					

RRSS activities – Safety reviews and advisory services

- Conducting INSARR review services - 15 INSARR/Expert Missions, on average per year.



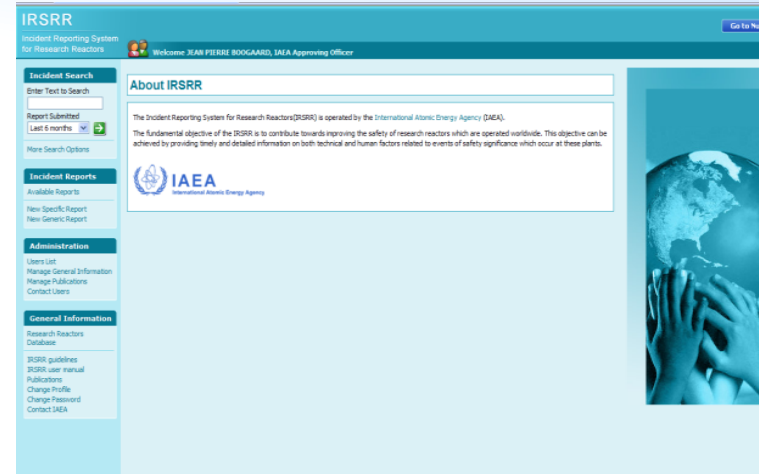
RRSS activities – Dissemination of operating experience

- Operating the Incident Reporting System for Research Reactors (**IRSRR**) and organizing regular meetings for exchange of operating experience and training on event investigation techniques. Next meeting is planned in August 2017.

- The IRSRR currently joined by 58 Member States (more than 95 % of facilities worldwide are covered).

- Operating experience from the events reported to IRSRR was published in 2015.

- <http://www-pub.iaea.org/books/IAEABooks/10847/Operating-Experience-from-Events-Reported-to-the-IAEA-Incident-Reporting-System-for-Research-Reactors>.



IAEA TECDOC SERIES

IAEA-TECDOC-1762

Operating Experience from
Events Reported to the
IAEA Incident Reporting
System for Research Reactors

RRSS activities – Monitoring the safety of Research Reactors under Project and Supply Agreements

- 27 research reactors in 23 countries are under Project and Supply Agreements with the IAEA.
- Collecting, analysing, and disseminating the results of Safety Performance Indicators (SPIs);
- Regular meetings on the safety of the research reactors under agreements and review of the SPIs of these facilities. Last meeting held in July 2017 included participants from 14 MS.
- Next meeting in 2019



RRSS activities – Capacity building – Education & Training

- Training workshops and technical meetings – more than 40 since 2010;
- Group Fellowship Training Course (NA, NE, NS, and TC);
- Online video presentations on safety standards and key technical areas for Research Reactors and Fuel Cycle Facilities;
- Training material;
- Coordinated Research Projects.



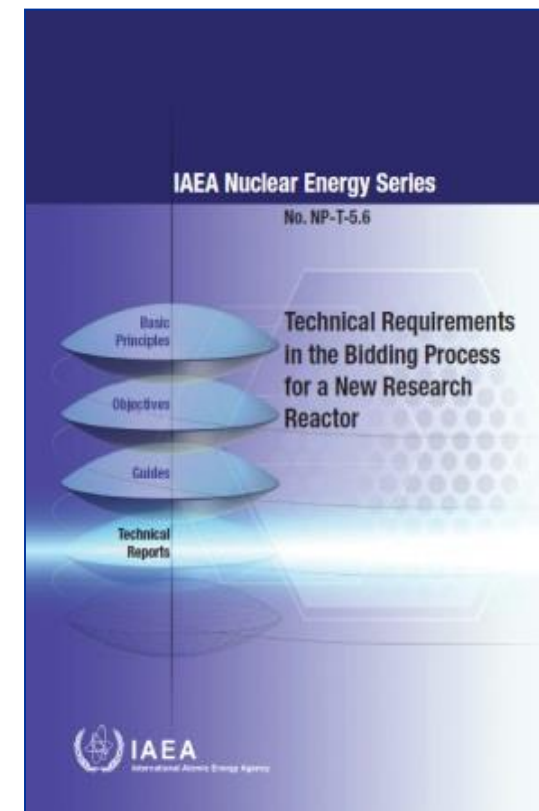
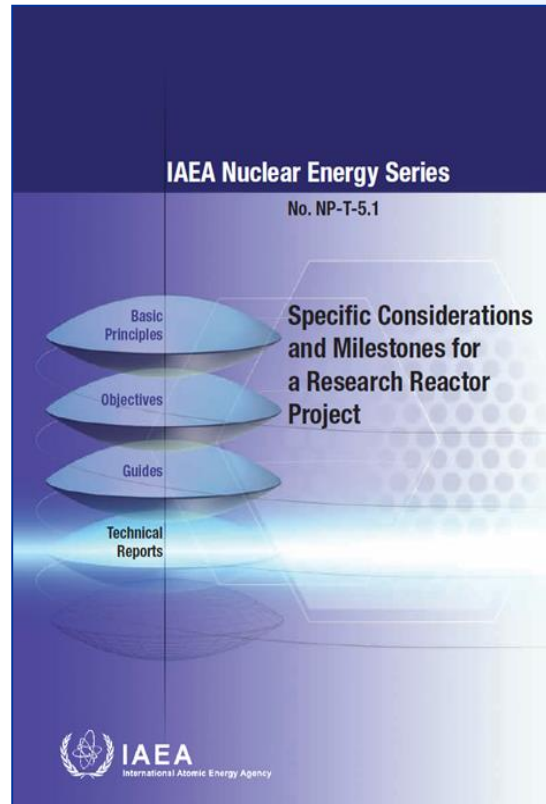
RRSS activities - Infrastructure for first/new research reactor programmes (with NE, NA, and TC)



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- Publications;
- Conduct of advisory services and expert missions;
- Training workshops and meetings.



RRSS activities on Safety Reassessments of Research Reactors in light of the Fukushima Daiichi Accident



- **Research Reactor Task Group Technical Meeting on Implications of Fukushima Daiichi Accident on the Safety of Research Reactors 24-25 April 2012;**
- **CS on Safety Reassessment of Research Reactors post Fukushima Daiichi Accident ('stress tests') 7-11 May, 2012;**
- **Technical Meeting on Implications of the Fukushima Accident on the Safety of Research Reactors, 14-18 May 2012;**
- **Workshop on Complementary Safety Assessments for Research Reactors following the Lessons Learned from the Fukushima Daiichi Accident, Vienna, 24-28 June 2013;**
- **ANSN regional workshop on Complementary Safety Assessment of Research Reactors Following the Lessons Learned from the Fukushima Daiichi Accident, Argonne, 9–13 December 2013;**
- **Publication of Safety Report Series No 80 “Safety Reassessment for Research Reactors in the Light of the Accident at the Fukushima Daiichi Nuclear Power Plant”, 2014;**
- **Regional Workshop on Safety Reassessment of Research Reactors in Light of Feedback from the Fukushima Accident, Rabat, 16-20 March 2015;**
- **Consultancy on the Implications of Fukushima-Daiichi Accident on Research Reactors, Tel Aviv, 27-30 April 2015;**
- **Workshop on Safety Reassessments of Research Reactors following the Feedback from the Fukushima Daiichi NP Accident, Vienna, 5-8 Sept 2016**

IAEA activities on the implications of Fukushima on research reactor safety – Technical Meetings and Workshops



International Meeting on Application of Code of Conduct on the Safety of Research Reactors (2014, 2017)



results of the reassessments.

Several workshops were dedicated to training on performing safety analysis and safety reassessment.

More than 45 MSs participated in these activities (operators, regulators, and technical support organizations).

Participants reported on their complementary safety assessment of research reactors and sites, which varied widely in scope and depth (many were based on



International Conference on Research Reactors: Safe Management and Effective Utilization (2011, 2015)

- In some cases it was concluded that the reactors could sustain certain initiating events beyond the design basis without significant radiological release;
- However, in many cases, the need for certain short-term and long-term modifications and upgrades were identified.



Regional Workshops on Safety Reassessments Research Reactors



Feedback from the survey on safety
reassessment in light of the accident at the
Fukushima-Daiichi nuclear power plant (2015)

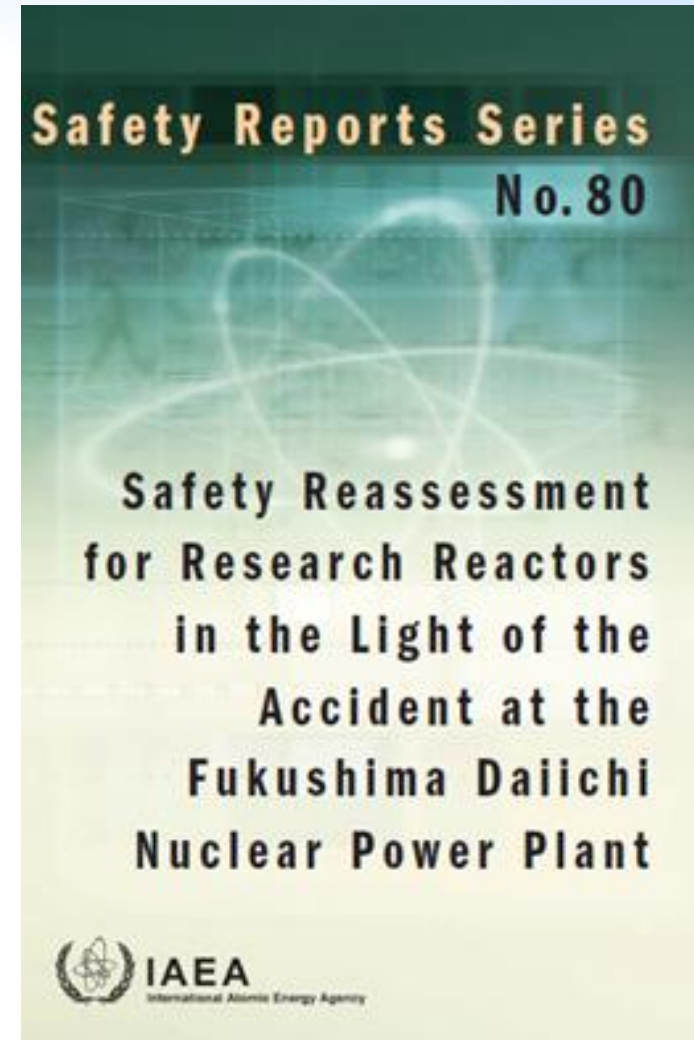
and

Workshop on Safety Reassessments of Research
Reactors following the Feedback from the
Fukushima Daiichi NP Accident, Vienna, (2016)

Feedback: General

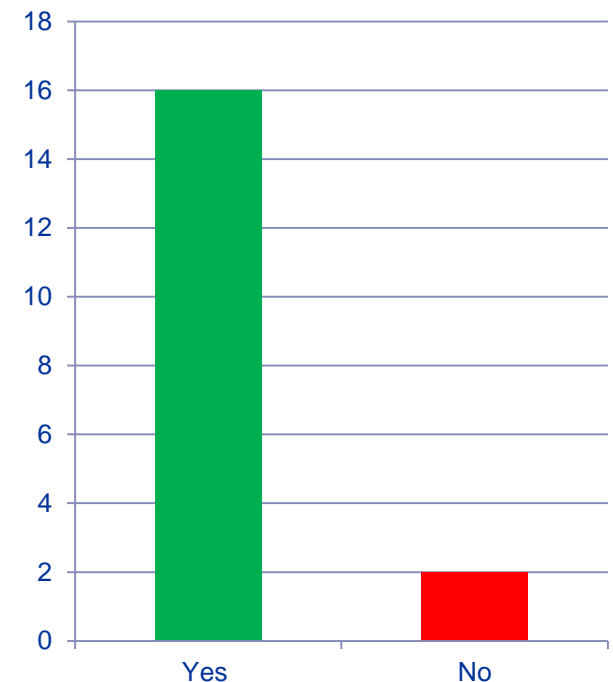
Feedback from the survey on safety reassessment of research reactors in light of the accident at the Fukushima Daiichi NPP:

- About 50% of MSs responded;
- 25 responses from operating organizations;
- 2 from regulatory bodies;
- 18 reassessments;
- 13 following IAEA SRS No. 80;
- Many safety enhancements.



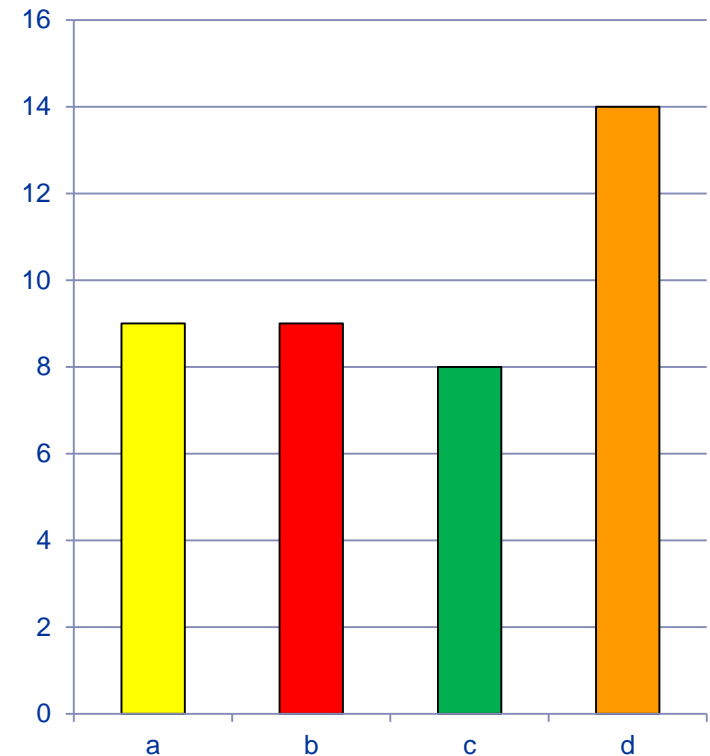
Did the reassessment include analysis of loss of electrical power supply, combinations of events and consequential events?

- Almost all responses indicated reassessment of DBAs and consideration of additional single external/ internal events, with emphasis on the loss of electrical power supply.
- Many reassessments included consequential events (e.g. earthquake with LOCA, loss of power supply).
- Some considered combined earthquake and flooding events and implemented related modifications (e.g. improvements on site accessibility and emergency preparedness).



Has the reassessment verified that the existing design provisions ensure that the basic safety functions will be fulfilled in the case of extreme external events?

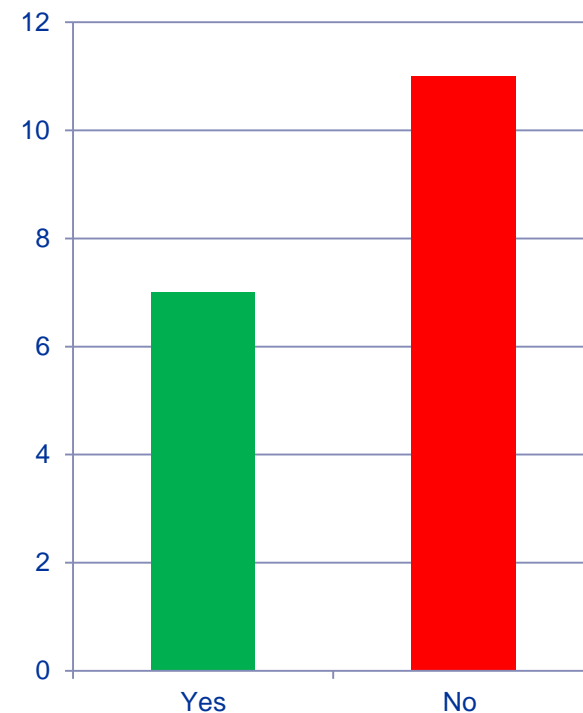
- a. Implementation of seismic monitoring and automatic protective actions, as well as increased protection of control rod drives.
- b. Modifications to strengthen protection against LOCA with loss of offsite electrical power.
- c. Enhanced seismic resistance of the reactor building; hardening of various structures, systems and components; some facilities installed emergency ventilation systems.
- d. Implementation of additional measures to protect existing electric power supplies (*spare cabling, redundant and separate external source lines, seismic resistance of UPS*), and added improved batteries, mobile/portable generators.



Feedback: Safety Organization

Has the reassessment resulted in changes in the reactor organizational aspects (e.g., reactor organizational chart, human factors, etc.) and/or relevant regulatory practices (e.g., licensing conditions, inspection programmes, etc.)?

- The majority of facilities did not change organizational aspects;
- Some facilities increased technical support and training for emergency response and strengthened the functioning of the reactor safety committee;
- Regulatory bodies reported that guidance on safety reassessments was developed consistent with SRS No. 80
- Improved Regulatory Independence



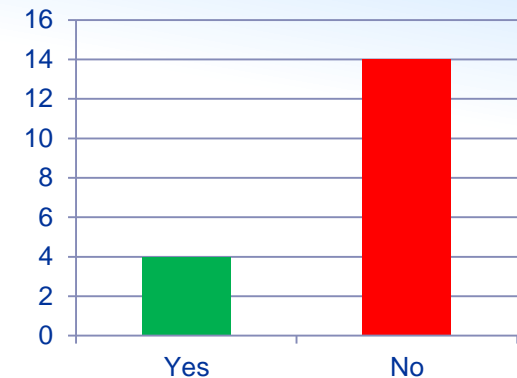
Have the existing emergency arrangements and procedures been reviewed, particularly for an accident initiated by an extreme external event affecting several facilities simultaneously?

Most facilities reported that the existing arrangements were generally adequate, but many made enhancements such as:

- Improving communication systems, increasing response forces and increasing emphasis on training of responders;
- Redesigning off-site access points and routes and upgrading roads within the facility site;
- Installing additional fire protection equipment and relocation of equipment into seismically qualified buildings;
- Performing exercises of BDBAs response, incorporating human factors training and increasing the frequency of emergency exercises that include offsite organizations.

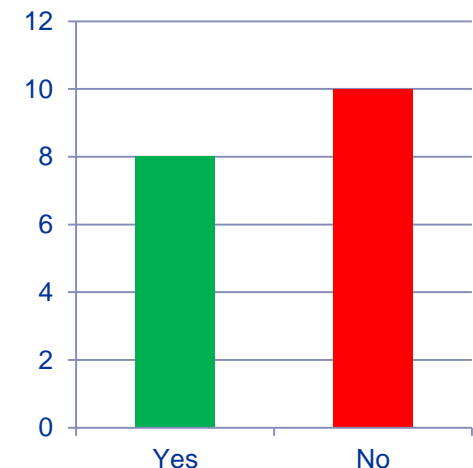
Has the reassessment resulted in changes in the safety analysis and conclusions presented in the SAR?

- Most facilities did not identify a need to update the SAR based on the reassessment.
- The SAR for other facilities is currently under revision or regulatory review and assessment.



Has the reassessment resulted in changes in the operating programme, including operating, maintenance and periodic testing procedures?

- Changes made to:
 - Cover new emergency response equipment (mostly reported);
 - Increase the frequency of preventive maintenance;
 - Establish procedures for abnormal conditions.



Feedback – Summary

- Most organizations who responded to the survey have performed reassessments following the guidance in SRS No. 80, or a similar national process.
- The majority have implemented modifications to SSCs, procedures, and emergency plans to strengthen robustness of the facility.
 - Improved and/or additional emergency equipment;
 - Provisions for protection of that equipment from extreme events;
 - Provisions for connection of external power and water supplies;
 - Hardening of various structures, systems and components, especially those required to maintain fundamental safety functions in an extreme event (earthquake, flooding, tornado, etc.);
 - Improved emergency procedures;
 - Operator training and exercises of the emergency response plans
- Efforts are still needed in many facilities to complete the reassessment (or to implement its results).
- New research reactor project should include consideration of lessons learned from Fukushima-Daiichi
- IAEA to continue organization of meetings/workshop on the topic.

Look ahead to 2018/2019

- **Project: Enhancing Safety of Research Reactors**

- Support application of Code of Conduct and development of IAEA safety standards and supporting documents
- Conduct peer-reviews and advisory services
- Support Member States to build capacity for safety infrastructure
- Enhancing safety of research reactors under projects and supply agreements
- Promote knowledge sharing and disseminate operating experience
- Cooperate with international organizations/groups
- International Conference on Research Reactors 2019

Concluding remarks - Focus 2018-2019

- Maintaining and expanding worldwide application of the Code of Conduct and the IAEA safety standards;
- Supporting Member States on ageing management of research reactors;
- Enhancing regulatory effectiveness, including infrastructure for first research reactor projects;
- Supporting Member States to perform (or implement safety upgrades resulting from) safety reassessments following the Fukushima accident;
- Improving management of the interface between safety and security for research reactors;
- Sustaining and improving international networking for sharing knowledge, operating experience and good practices.



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Thank you!

