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NUCLEAR ENERGY AGENCY
COMMITTEE ON NUCLEAR REGULATORY ACTIVITIES

NEA/CNRA/R(2004)1
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WORKING GROUP ON INSPECTION PRACTICES (WGIP)

COMPARISON OF INSPECTION PRACTICES OF RESEARCH REACTORS IN RELATION TO THE PRACTICES CARRIED OUT AT NUCLEAR POWER PLANTS

English text only

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ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

Pursuant to Article 1 of the Convention signed in Paris on 14th December 1960, and which came into force on 30th September 1961, the Organisation for Economic Co-operation and Development (OECD) shall promote policies designed:

- to achieve the highest sustainable economic growth and employment and a rising standard of living in Member countries, while maintaining financial stability, and thus to contribute to the development of the world economy;
- to contribute to sound economic expansion in Member as well as non-member countries in the process of economic development; and
- to contribute to the expansion of world trade on a multilateral, non-discriminatory basis in accordance with international obligations.

The original Member countries of the OECD are Austria, Belgium, Canada, Denmark, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The following countries became Members subsequently through accession at the dates indicated hereafter: Japan (28th April 1964), Finland (28th January 1969), Australia (7th June 1971), New Zealand (29th May 1973), Mexico (18th May 1994), the Czech Republic (21st December 1995), Hungary (7th May 1996), Poland (22nd November 1996), Korea (12th December 1996) and the Slovak Republic (14 December 2000). The Commission of the European Communities takes part in the work of the OECD (Article 13 of the OECD Convention).

NUCLEAR ENERGY AGENCY

The OECD Nuclear Energy Agency (NEA) was established on 1st February 1958 under the name of the OEEC European Nuclear Energy Agency. It received its present designation on 20th April 1972, when Japan became its first non-European full Member. NEA membership today consists of 28 OECD Member countries: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, the Netherlands, Norway, Portugal, Republic of Korea, Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The Commission of the European Communities also takes part in the work of the Agency.

The mission of the NEA is:

- to assist its Member countries in maintaining and further developing, through international co-operation, the scientific, technological and legal bases required for a safe, environmentally friendly and economical use of nuclear energy for peaceful purposes, as well as
- to provide authoritative assessments and to forge common understandings on key issues, as input to government decisions on nuclear energy policy and to broader OECD policy analyses in areas such as energy and sustainable development.

Specific areas of competence of the NEA include safety and regulation of nuclear activities, radioactive waste management, radiological protection, nuclear science, economic and technical analyses of the nuclear fuel cycle, nuclear law and liability, and public information. The NEA Data Bank provides nuclear data and computer program services for participating countries.

In these and related tasks, the NEA works in close collaboration with the International Atomic Energy Agency in Vienna, with which it has a Co-operation Agreement, as well as with other international organisations in the nuclear field.

COMMITTEE ON NUCLEAR REGULATORY ACTIVITIES

The Committee on Nuclear Regulatory Activities (CNRA) of the OECD Nuclear Energy Agency (NEA) is an international committee made up primarily of senior nuclear regulators. It was set up in 1989 as a forum for the exchange of information and experience among regulatory organisations and for the review of developments which could affect regulatory requirements.

The Committee is responsible for the programme of the NEA, concerning the regulation, licensing and inspection of nuclear installations. The Committee reviews developments which could affect regulatory requirements with the objective of providing members with an understanding of the motivation for new regulatory requirements under consideration and an opportunity to offer suggestions that might improve them or avoid disparities among Member Countries. In particular, the Committee reviews current practices and operating experience.

The Committee focuses primarily on power reactors and other nuclear installations currently being built and operated. It also may consider the regulatory implications of new designs of power reactors and other types of nuclear installations.

In implementing its programme, CNRA establishes co-operative mechanisms with NEA's Committee on the Safety of Nuclear Installations (CSNI), responsible for co-ordinating the activities of the Agency concerning the technical aspects of design, construction and operation of nuclear installations insofar as they affect the safety of such installations. It also co-operates with NEA's Committee on Radiation Protection and Public Health (CRPPH) and NEA's Radioactive Waste Management Committee (RWMC) on matters of common interest.

ABSTRACT

This report presents a comparison of inspection practices at Research Reactors (RR) versus Nuclear Power Plants (Nuclear Power Plants) in participating OECD Nuclear Energy Member Countries. Key questions for this comparison are:

> "Is the Research Reactor inspection process as applied by regulatory bodies organised differently compared to the Nuclear Power Plant inspection process", and ‘What inspection areas get more or less attention and why".

The Working Group on Inspection Practices (WGIP) suggests countries should implement a graded approach to regulatory inspection of Research Reactors, which is based on the existing experience of Nuclear Power Plant inspection, taking the technical properties and safety features of Research Reactors into due account.

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FOREWORD

The CNRA believes that safety inspections are a major element in the regulatory authority's effort to ensure safe operation of nuclear facilities. Considering the importance of these issues, the Committee has established a special Working Group on Inspection Practices (WGIP).

The purpose of WGIP is to facilitate the exchange of information and experience related to regulatory safety inspections between CNRA Member countries.

Questions of nuclear safety of Research Reactors and their regulatory control have gained increasing attention. The IAEA Safety Standards and Guides for Research Rectors are under further development within the IAEA Safety Standards Programme. The "Code of Conduct on the Safety of Research Reactors" has been developed, the draft being currently under consideration for approval by the IAEA member states.

In 1999 a proposal was made to perform an internal WGIP report based on responses to a survey about how Research Reactors are inspected. The CNRA approved work on this and an initial questionnaire was set up in 2000. Based on the contributions of several Member countries a preliminary outcome of the survey was made and it was decided that additional questions had to be elaborated to understand why some inspection-areas at Research Reactors are handled in a different way than at a nuclear power plant.

As noted in the text, seventeen member countries supplied input by responding to the questionnaire. The authors wish to thank all those members of WGIP and their associated colleagues for their contributions.

1. INTRODUCTION

This report presents a comparison of inspection practices at Research Reactors (RR) versus Nuclear Power Plants (Nuclear Power Plants) in participating OECD countries. The report has been derived from responses received from a questionnaire on the basis of guidance given in Appendix 1 and with detailed answers on clarifying questions given in Appendix 2.

The key questions for this comparison are: "Is the Research Reactor inspection process as applied by the regulatory bodies organised differently compared to the Nuclear Power Plant inspection process", and "What inspection areas get more or less attention and why".

In order to do this comparison it was necessary to identify the differences in regulatory aspects of the Research Reactors compared to the Nuclear Power Plants in each participating country. Hence questions are asked about:

- the existing legal requirements
- the license requirements
- the organisation of the regulatory inspection
- the applied inspection programme and
- the inspection focus

2. COUNTRIES WHICH PARTICIPATED

Seventeen (17) countries provided answers to the questionnaire. The countries were: Belgium, Canada, Czech Republic, Finland, France, Germany, Hungary, Italy, Japan, Korea, Mexico, Netherlands, Spain, Sweden, Switzerland, United Kingdom and United States of America.

3. CONCLUSIONS

In general the organisation of the inspection process for Research Reactors is basically the same as for Nuclear Power Plants.

Most of the countries that responded stated that they have comparable sets of legal requirements for Research Reactors as they have for Nuclear Power Plants. Within the operating license conditions, most of the items described and the inspections (in all cases) by the Regulatory Body are organised similar to the way as performed for Nuclear Power Plants.

The frequency of inspections of Research Reactors varies in the Member Countries from 0.5 to 12 times a year. This rate is determined by several factors, such as the size and the risk level of the facility.

The attention paid to the various areas of an inspection is fundamentally the same as for Nuclear Power Plants. Less attention (in some areas) can be attributed to the lower risk of Research Reactors or that the particular area of inspection is not applicable. In a few areas more attention paid. These are radiation protection and assessment of experiments.

4. CONSIDERATIONS

In the Working Group discussions resulting from the responses to the questionnaire, it was recognised that many of the existing operating license conditions had been set up in a period in which the use of nuclear power just had started.

Since that time new techniques and risk insights have been developed. One of the methods to update information on the plant's safety status under these changed conditions is to carry out periodic reviews.

5. COMMENDABLE PRACTICES

From the outcome of the questionnaire and the comparison of the detailed results it was not possible to extract clear and concise inspection practices used by member states, which could be considered candidates for identified commendable practices. The individual responses show a scattered picture about the inspection of Research Reactors in Member Countries.

In order to find Commendable Practices covering the regulatory inspection of Research Reactors, extensive discussions were conducted at the WGIP meeting in October 2003. The ideas and considerations, which obviously already had given the basis of the current practices in NEA member states, can be summarised and presented as given below.

5.1 Discussion of inspection philosophy for Research Reactors

In comparing Research Reactors and Nuclear Power Plants, very often the following statements are made:

a. Due to their smaller size and power Research Reactors have a smaller radioactivity inventory and may therefore be considered as posing a much lower risk as compared to Nuclear Power Plants,

b. For most Research Reactors designs a catastrophic core melt accident is not conceivable.

But also the following facts should be taken into consideration:

a. Many Research Reactors have been built to earlier standards in design and attention may not have been given to extreme conditions as it is done in current designs.

b. From the WGIP survey it can be seen that probabilistic safety analyses have not been performed for most Research Reactors.

c. Radiation protection standards have been developed quite substantially since the 1960’s, which has resulted in higher requirements for construction and local shielding of working places for Nuclear Power Plants. Research Reactors probably have not been back-fitted accordingly.

d. Many Research Reactors are situated on university campuses in densely populated areas.

e. Many Research Reactors are operated by university personnel; the head of the operating organisation may not be specifically educated or trained in nuclear engineering.

f. Operation of a Research Reactors is performed to meet the needs of experiments; the degree of safety consciousness of the personnel may not have been discussed in the same depth as done for Nuclear Power Plants.

g. Regulatory Bodies may be tempted to inspect Research Reactors in a less diligent manner.

If not taken into due account, the resulting actual risk from the Research Reactors to the public or to the personnel could possibly be underestimated or at least be regarded differently as compared to Nuclear Power Plants.

Looking at the legal instruments available in all countries (as derived from the questionnaire):

a. The regulatory framework for licensing a Research Reactor is the same as for Nuclear Power Plants,

b. Regulatory requirements for design, construction and operation are in place, often the same as for Nuclear Power Plants, only a few are specific for Research Reactors,

c. Research Reactors operation is under regulatory control (licensing and inspection) formally in the same way as for Nuclear Power Plants,

WGIP suggest countries should implement a graded approach to regulatory inspection of Research Reactors, which is based on the existing experience of Nuclear Power Plant inspection, taking the technical properties and safety features of Research Reactors into (due) account. This graded approach and corresponding conclusions are aimed to strengthen the regulatory inspection control on Research Reactors.

5.2. Graded approach to regulatory control

WGIP notes that under the International Atomic Energy Agency (IAEA) the "Code of Conduct on the Safety of Research Reactors" is being developed. The draft is currently under consideration for approval by the member states. Also the IAEA Safety Standards and Guides for Research Rectors are under further development within the IAEA Safety Standards Programme. The following statement is taken from the Draft Safety Requirements of Research Reactors (November 2003):

> *"A number of requirements for the safety of Research Reactors are the same or very similar to those for power reactors. Considering the important differences between power and Research Reactors and even between the different types of Research Reactors the application of these requirements shall be commensurate to the potential hazard of the reactor using a graded approach ...., ensuring that the design and operation of a research reactor lead to adequate safety of the facility."*

In accordance with this statement and with other international considerations on this topic, WGIP agreed on the following:

> *Regular Inspections of Research Reactor Facilities should be graded for both frequency and depth, based upon the factors of potential hazard, complexity, safety culture and public concern. For special activities or experiments the inspection authority should draw appropriate attention.*

5.3 Concluded Commendable Inspection Practices

A graded inspection approach based on appropriate safety considerations may be broken down into the following commendable inspection practices:

a. Research Reactors are always regarded as a nuclear facility, being regulated under the same legal national regulatory framework as any other nuclear facility (Nuclear Power Plants, fuel fabrication plants, reprocessing plants, spent fuel storage, etc.).

b. The regulatory inspection authority for Research Reactors is organised within the national regulatory authority competent for all other nuclear facilities.

c. The regulatory inspection authority inspects the design, construction, operation and decommissioning of Research Reactors using a set of appropriate regulatory requirements. If not specifically established, these requirements are the same as for Nuclear Power Plants. If needed, these requirements are graded to the special conditions of the Research Reactor (operation at zero power, experimental conditions, etc.).

d. The regulatory inspection authority sets up an inspection programme which is oriented on the inspection programme of Nuclear Power Plants as far as safety features are concerned.

e. The regulatory inspection authority pays attention to the requisite qualification and training of Research Reactors personnel.

f. The regulatory inspection authority pays special attention to the routine operation of the Research Reactors under the given circumstances of research and experimental business. This includes among other items radiation protection, fire protection, work safety and housekeeping.

g. The regulatory inspection authority considers the use of probabilistic safety assessments to judge on the adequacy of the safety level of a Research Reactors.

h. The regulatory inspection authority considers the use of periodic reviews to follow up any new techniques and risk insights as to nuclear safety and to implement - as appropriate - lessons learned from the periodic safety reviews of Nuclear Power Plants.

5.4 Example for a country specific implementation of Reactor Research inspection strategy

Due to the wide variation of installed Research Reactors in different countries it is not feasible to suggest quantitative figures for inspection depth and frequency to implement a graded approach.

The following method has been used in one country to judge the necessary regulatory inspection effort that is required. This example may serve as guidance for other countries to either implement or check their own graded approach. (In this method other nuclear installations may be inserted too.) The basis for this is the current and established regulatory control on nuclear power plants.

5.4.1 Frequency of inspections

The frequency of inspections is determined by the following parameters:

- potential hazard,
- complexity of the installation,
- safety culture, and
- public concern.

These parameters are given each a rating factor of 10 for Nuclear Power Plants and an appropriate individual factor for Research Reactors (or other installations).

The frequency is based on the established inspection frequency for a Nuclear Power Plant. This frequency is one inspection visit every week and daily inspections during refuelling periods.

As a first approximation the required yearly frequency for inspection visits is calculated using the sum of the rating factors proportional to the respective number for Nuclear Power Plants.

Installation	Rating of Parameters				Sum of Ratings	Routine Inspection
	Potential Risk	Complexity	Safety Culture	Public attention	Total	Inspection visits per year
Nuclear Power Plant	10	10	10	10	40	52
Research Reactor 45 MW	2	2	5	10	19	25
Research Reactor 4 MW	1	1	2	5	9	12

5.4.2 Depth and scope of regulatory inspection

For determining the required depth of inspections again the inspection practices for Nuclear Power Plant is the basis. As a first approximation the depth should be the same as for Nuclear Power Plant. However, as the extent of installed structures, systems and components is less than for a Nuclear Power Plant, it is evident that the capacity needed for regulatory inspection will be lower accordingly.

Concerning the scope of inspection, the following aspects should be covered:

- Reactor Safety,
- Radiation Safety (for the personnel and for the environment),
- Fire Safety,
- Safety Culture,
- Security (physical protection of the facility plus material control and accounting (safeguard)),
- Emergency Preparedness,
- Experiments and special activities.

APPENDIX 1

Countries will be identified by a number as indicated below the tables in this appendix

Number	Country	Type Reactors
1	Canada	**5x 20 kW; 1x 5 MW**; 2x10 MW, 1x 135 MW
2	Finland	1x 250 kW
3	France	12 RR in operation (5 RR from 0.1 kW to 700 kW, 7 RR from 14 MW to 350 MW); 6 RR in decommissioning; 1 RR in planning
4	Germany	4 RR in operation (**0.1; 5, 10, 23 MW**); 1 RR under commissioning (**20 MW**); 11 RR under decommissioning (0.24 to 44 MW) in addition: 9 RR (<50 kW) in operation
5	Hungary	2 RR (1x100 kW; 1x10 MW)
6	Mexico	1 RR (1 MW)
7	Netherlands	1x 30 kW; 1x 2 MW; 1x 45 MW
8	United Kingdom	3 RR in operation (1x300 Wth, 1x100 Wth, 1x 20,000 MW Pulse)
9	United States	About 50 RR
10	Switzerland	1x 5 kW
11	Belgium	2 RR (BR2 + Thetis) operating; 1 RR (BR3) in decommissioning
12	Japan	16 RRs, 1W – 140 MW), 7 RR under decommissioning
13	Italy	4 RR in operation (20 W, 5 kW, 350 kW, 1MW) 1 RR under decommissioning
14	Sweden	2RR; 50 MW and 1 MW
15	Czech Republic	2RR + 1 school reactor
16	Korea	2 RR in operation (30 MW, 0.1 W), 2 RR under decommissioning (0.25, 2 MW)

Notes:

- In **Spain** the operation of the three Research Reactors was stopped in 1975 (2x 1 kW) and in 1987 (3 MW). The fuel assemblies were transported in 1992 and the reactors are now under decommissioning. Due to this situation most answers on the questionnaire are "Not

Applicable". As the questionnaire was intended to get a picture of inspection of operating Research Reactors the contribution of Spain is not incorporated in the Annex.

- In **Italy** no Nuclear Power Plant's are present; the comparison of a specified situation with that at a Nuclear Power Plants can not be done. However the answers given in section 1 up to number 4 provide insights on how Italy is inspecting Research Reactor and therefore these answers are incorporated in this document.

- When the type reactors stated in "bold", the answers on this questionnaire are based on these reactors.

The questionnaire was developed to attain insights into the following subjects:

1. LEGAL REQUIREMENTS.

   - Concerning the legal system, are Research Reactors (RR) treated in the same way as Nuclear Power Plants (Nuclear Power Plants)?

2. LICENSE REQUIREMENTS.

   - Do Research Reactor licenses have the same sort of requirements described as for a Nuclear Power Plants?

3. REGULAR INSPECTIONS

   - Is the Regulatory Body organisation to inspect Research Reactors set up in the same (comparable) way as to inspect a Nuclear Power Plant?

4. INSPECTION PROGRAMME.

   - How are inspections organised and carried out at Research Reactors?

5. INSPECTION FOCUS.

   - Is the same level of attention paid to the various inspection areas as at Nuclear Power Plants?

1. Legal Requirements

LEGAL REQUIREMENTS	AS FOR NPP	ABSENT	REMARKS
Acts, Decrees valid	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16		7: Also IAEA Safety Series 35 8: Prescribed sites regulations limiting liability cover 9: Regulations scaled to be appropriate for the specific reactor type. 13: Regulations scaled for power less than 100 kW.
License needed	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16		8: Unless Crown immunity 9: Construction and operation license can be combined for RR.
Safety report needed	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16		1: Description and accident analyses 13: Description and accident analyses
INES system	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16	(5), 13	1: Done by regulator 4: No legal requirement for INES, but put into practice by all licensees (NPP and RR) within the legal requirements for event reporting (Nuclear Safety Officer and Reporting Ordinance AtSMV). 5: No legal requirements for INES, but licensee have to submit reports of events in RR. Practically the INES reporting system is valid for RR from Jan. 1, 2000 7: By letter to all licensees 13: No legal requirements for INES
Waste disposal regulations	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16	(5)	5: Regulations focus on radioactive waste management in nuclear installations. A new decree is in elaboration.
Emergency Preparedness	2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16		1: very little requirement for planning at municipal (town) level 8: generally no off-site plan
Decommissioning	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16	6	
Enforcement	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16	(5), 6	5: HAEA may impose a fine on licensees. The enforcement policy of HAEA is in elaboration.

2. License Requirements

LICENSE REQUIREMENTS	AS FOR NPP	ABSENT	REMARKS
Limits for Radioactive effluents	3, 4, 5, 6, 7, 8, 9, 11, 12, 13, 14, 15, 16	1, 10	1: little effluents, requirements to monitor on reactors > 2 MW 2: Dose limit 0.01 mSv (NPPs 0.1 mSv) based on the environmental dose assessment of FiR 1 (TRIGA) 4: Limit setting as for NPP, for measurement and reporting specific KTA Safety Standard exists. 5: New regulation for RR is introduced in 2001. 9: Sometimes in TS additional requirements for unique experiments 10: No individual limits, but for the whole site (research centre PSI) 13: If RR in research centre also for the whole site
Operational License Conditions	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16		
Quality Assurance System	2, 3, 4, 5, 6, 7, 8, 9, 12, 13, 14, 15, 16	1, 10, 11	1: No formal program, but a few procedures 10: RR are individually treated 11: Present, but not required
Incident reporting system	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 12, 14, 15, 16	11, 13	4: Specific reporting criteria for RR exists 7: Criteria are different for NPPs 11: Informal; not in license 13: Not in license but following nuclear acts
Maintenance / test programs	1, 2, 3, 4, 5, 7, 8, 9, 10,12, 14, 15, 16	11, 13	1: Small 9: Minimum requirements necessary consistent with Atomic Energy Act. 11: Existing; not in license 13: generally not in main license

LICENSE REQUIREMENTS	AS FOR NPP	ABSENT	REMARKS
In-Service Inspection program	3, 4, 5, 8, 14, 15, 16	1, 2, 6, 7, 9, 10, 11, 12, 13	1: Only sporadic for 5 MW; not a program. 2: There are no pressure retaining components connected to the reactor circuit (open pool reactor). 6: Reduced compared with NPP mainly focussed to liners 7: Only 3 items, 2x Containment; 1x reactor vessel 9: Only simple surveillance program; see also appendix 2. 10: Reduced compared with NPP 12: Inspection of compliance with safety provisions was established in Dec. 1999 13: Sporadic, not a scheduled program
(L)PSA	8, 15	1, 2, 4, 5, 6, 7, 9, 10, 11, 12, 13, 14, 16	2: Due to the non-dynamic features of TRIGA reactor it is assessed that PSA tools are not beneficial. 4: In most cases much smaller nuclear risk than NPP, smaller and less process systems than NPP. Parts of a PSA were done for the new RR at Munich-Garching (FRM-II). 5: The licensees are obliged to elaborate a safety assessment on the basis of deterministic events. 6: There is not sufficient data for PSA 8: Requirement for deterministic supported by probabilistic. 9: See explanation in appendix 2 10: Reduced compared with NPP 11: PSA exists for BR2 12: PSA is done for NPPs in periodical safety review, but not for RR.
Grading materials	3, 4, 5, 6, 8, 10, 12, 13, 14, 15, 16	1, 2, 7, 9, 11	1: No class of material 3: 1 grade instead of 3 for NPP 8: no grading 9: See explanation in appendix 2

LICENSE REQUIREMENTS	AS FOR NPP	ABSENT	REMARKS
Containment functions	(1), 3, 6, 7, 8, 9, 11, 12, 16	(1), 2, 4, 5, 10, 13, 14, 15	1: yes for 5 MW, no for the other 2: No containment 4: A confinement is realised, only the new RR at Munich-Garching FRM-II has a containment to cope with design basis accidents and aircraft crashes. 5: the 2 RR were constructed into reactor buildings. Considering the environmental consequences of a postulated accident, it has been verified that establishing of the containment and containment functions would be unjustified. 7: not at the 30 kW RR 8: Not as per PWR 11: For BR2/BR3; absent for other RR 13: according to type of RR 15: no containment 16: legally required, but the confinement concept has been accepted
Reactor Safety Committee (RSC) (independent reviewing group of the licensee)	3, 5, 6, 7, 8, 9, 12, 14, 15, 16	1, 4, 10, 11, 13	1: For radiation protection only 2: Internal committee of the license holder 4: But Reactor Safety Commission (RSK), an independent advisory committee deals also with RR questions on request of Federal Ministry BMU 10: 1 expert named by the licensee 13: Internal committee of the license holder with ANPA representative 15: Reactor Safety Commission for Operation
Qualification reactor personnel	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 13, 14, 15, 16	7, 12	4: Specific qualification and training guidelines exist for RR, similar as NPP, but tailored to requirements for RR-operation 7: No special examination / certification is required. 9: Other standards than for NPP 11: Existing for BR2, was not in license; recently it is regulated. 12: There is a chief reactor engineer, but is not chief operator both NPPs and RR's 13: Tailored to requirements of RR
Radiation control/supervision	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16		1: very little 4: Specific requirements for RR (supplement to guideline which is valid for all nuclear facilities) 9; Implementation tailored to RR

LICENSE REQUIREMENTS	AS FOR NPP	ABSENT	REMARKS
Monthly/quarterly reporting of operation performance	1, 3, 4, 5, 6, 7, 8, 12, 14, 15, 16	9, 10, 11, 13	1: yes for 5 MW; other yearly 2: Annual reporting 3: 6 months to 1 year 5: For all types of nuclear installations submission of quarterly reports are required. 8: Reactor manager reports to NSC 9: Annual reporting; see also appendix 2 10: Annual report 13: Annual report 15: Quarterly report 16: Quarterly report on radiation control
Periodical Assessment	3, 5, 6, 7, 8, 9, 11, 14, 15	1, 2, 4, 10, 12, 13, 16	1: only emergency response 2: For FiR 1 the operation licence for the present is valid 2000-2011. This period is considered to be the basis of in-depth safety analysis (in addition to regular inspections). 3: 10 yearly 4: Some have been carried out according to needs (smaller nuclear risk than NPP, smaller and less process systems than NPP), no requirement for Periodic Safety Review 5: Annual report and 10 year PSR 6: 10 years 7: not at 30 kW RR. 8: 10 year PSR 9: Less frequent as at NPP and narrower topic areas 10: Depending on projects 11: For BR2 12: MEXT periodically inspects RR's, but does not assess them as NPPs 13: Depending on projects

3. Regular Inspections

REGULATOR INSPECTION	AS FOR NPP	ABSENT	REMARKS
Inspection responsibility	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16		1: Lic. + Ins. by same group, supported by specialist divisions 4: Inspection philosophy essentially is the same as for NPP. 9: Within NRC a specific group (10 persons) for (50) RR's. 13: Lic. + Ins. by same group
Use of resident inspectors	11, 12: Yes, there are resident inspectors 1, 2, 3, 4, 5, 7, 8, 10, 13, 14, 15: No resident inspectors	6, 9, 16	4: As for NPP, inspectors of the regulatory body are assigned to inspection of individual plants. 6: Reactor operates only twice a week 9: See explanation in appendix 2 5: The same resident inspectors (on site NPP) of the regulatory body are assigned to inspection of the Research Reactors.
Same inspectors as at NPPs	2, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16	1, 3, 9	3: Generally not, but possible 4: Supported by TSOs, here expert organisations (TÜV). 9: Separate specialists in RR inspection; see also in appendix 2 12: METX inspector
Inspection plan/programme available	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16		1: A yearly plan 4: Inspection philosophy essentially is the same as for NPP. 9: RR: NRC manual Chapter 2545 NPP chapter 2515. 11: Available, but less formalised 13: A yearly plan
Inspection procedures available	1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 14, 15, 16	7, 13	1: Check sheets only 4: Inspection philosophy essentially is the same as for NPP. 5: Dedicated to the 2 RR 7: Procedures of NPP doesn't fit 9: Inspection procedure 69001 11. Available, but less developed 13: Check sheets

REGULATOR INSPECTION	AS FOR NPP	ABSENT	REMARKS
Training qualification of inspectors	1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16	2, 13	1: In Act, regs, enforcement 2: No specific training for RR 4: Inspection philosophy essentially is the same as for NPP. 7: No specific training for RR 9: NRC manual Chapter 1245 13: No specific training for RR
Regular contact on management level with licensee	1, 3, 4, 5, 6, 7, 8, 9, 12, 13, 14, 15, 16	2, 10, 11	4: Inspection philosophy essentially is the same as for NPP, but inspection contacts not as frequent as for NPP. 5: Case by case 7: Not at the 30 kW RR 10: RR is part of the PSI-organisation
Reporting system to public / Parliament.	1, 2, 3, 4, 5, 7, 8, 9, 10, 11, 12, 15, 16	1, 6, 11, 13	1: Only to parliament, not to public 4: Reporting requirements and procedure for RR same as for NPP, RR events are included in the event listing for NPPs. Reporting criteria are tailored to the specifics of RR. Documentation and evaluation by regulatory body same as for NPP 6: Only to the Ministry of Energy 7: Only to parliament, not to public 11: Not to public 13: Not applicable

4. Inspection Programme

What is the frequency of inspections?

Country Answer

1. 1 day per year on site (the 135 MW: 9x2 days + 1week audit)

2. Annually

3. 1 to 6 times a year

4. As necessary, mostly monthly, in total less then for NPP

   Comment: Safety orientated, smaller risk than NPP, less inspection amount, inspection philosophy essentially is the same as for NPP.

6. On a biannual basis

7. According to planning at least 4 inspections a year and 1 week audit every 5 years. If there are special activities or projects the inspection frequency is higher. So it was decided that due to “public and politic interest the inspection frequency was increased” for the 45 MW Research Reactor from once in three months to once a month.

8: 3 to 4 times annually.

9. 1 time a year for Research Reactor < 2 MW; 2 times a year for Research Reactor > 2 MW.

10. Depends on projects

11. 2 times a month for BR2 and Thetis; 1 times a month for BR3 (in decommissioning)

12. Periodical inspection for facilities: 1 time a year. Inspection for observance of Self-safety regulation: 4 times a year.

14. 5 to 6 times a year

15. up to 20 per year in accordance with inspection plan

16. Periodical inspection for facilities: 0.5 times a year. Inspection for quality assurance: 0.5 times a year.

What determines this frequency?

Country	Answer
1.	Historic decision, problems/actual risk, availability of staff
2	The size and safety importance of the Research Reactor; also maintaining expert knowledge of inspector
3	Risk level
4	Mainly regular in-service inspections and tests, reportable events
6	Mainly the results obtained from the inspections carried out by inspection team
7	Risk, complexity, special experiments and interest of public and/or parliament.
8:	Risk and activities i.e. experiments
9	The size and safety importance of the Research Reactor
10	Projects
11	Complexity of reactor
12	Law on the regulation of nuclear source material, nuclear fuel material and reactors.
14	The prioritisation made in yearly inspection plan. Events and safety issues under discussion
15	Licensing process needs.
16	Partial refuelling period (about 2 weeks), test periods of major components, and degraded approach for Research Reactor

Compared with NPP, is the inspection

Level of contact within the organisation of the licensee higher/lower

Higher	Same	Lower	Remarks
3, 7,	4, 5, 8, 9, 11, 12, 14, 15, 16	1, 2, 6, 10	1: Initially low level, with changing to higher level in last few years when persistent problems are not attended. 8: Similar but smaller organisation 9: Relatively about the same 10: Lower because Research Reactor is part of the PSI-organisation

More/less guided by the licensee

More	Same	Less	Remarks
6, 7	2, 3, 5, 8, 10, 11, 12, 14, 15, 16		1: No, decided by inspector 2: Generally equally 4: Guided by operation and safety performance 7: More guided (by management) as most of these inspections are announced in advance to discuss (potential) problems with management 9: Inspectors choose equipment to be examined 10: In principle the same procedure

More/less "desk-orientated" then "field-orientated"

More	Same	Less	Remarks
4, 6, 7, 10,	2, 3, 8, 11, 12, 14, 15, 16		1: Combination of paper tracking and field inspection and review. 2: Generally equally 4: similar to NPP, but in total less work, therefore somewhat more "desk-oriented" Comment: Safety oriented, smaller nuclear risk than NPP, smaller and less process systems and equipment than NPP, less total inspection amount, inspection philosophy is the same as for NPP. 8: Some inspection is of records at the site, but to extent possible inspectors try to observe actual activities

Notes:

Due to absence of Nuclear Power Plants no information obtained from Italy (13)

5. Inspection Focus

INSPECTION FOCUS	COMPARED WITH Nuclear Power Plants			
See Appendix 2 for clarifications				
	MORE	SAME	LESS	NOT APPLICABLE
License compliance	7	1, 3, 4, 5, 6, 8, 9, 10, 11, 12, 14, 15, 16	2***, 11	
Good house keeping	5, 11	1, 3, 6, 7, 8, 9, 10, 11, 12, 14, 16	2, 4, 15	
Operation performance		1, 5, 6, 8, 9, 11, 12, 14, 15, 16	2, 3, 4, 7, 10	
Radiation control	7, 11	1, 3, 4, 5, 6, 8, 9, 10, 11, 12, 14, 15, 16	2	
Control maintenance performance		3, 6, 8, 9, 11, 12, 14, 15, 16	2, 4, 5, 7, 10, 11	1, 11*
Witnessing maintenance		8, 9, 11, 12,14, 15, 16	2, 4, 5, 6, 10, 11	1, 7, 11*
Control test performance		3, 4, 8, 9, 11, 12, 14, 15, 16	2, 5, 6, 7, 10, 11	1, 11*
Witnessing tests		8, 9, 11, 12, 16	2, 4, 5, 6, 10, 11, 15	1: review afterwards, 7, 11* , 14
Core calculations		4, 5, 6, 8, 9, 11, 14, 15, 16	1, 10, 12	1: only for 5 MW 2, 3, 4: less inspection work than for NPP, special inspections and calculations as needed, 7, 10: Reference core only, 12**: Inspection does not cover core calculation in each fuel load
Criticality		1, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16		2, 3
Event reporting		1, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16	2	
Assessment of experiments	3, 7, 9, 11, 12	5, 6, 8, 15, 16	10	1 (Licensee defines criteria within limits established by regulator), 2, 4 (RR: only if safety related modifications are involved, NPP: normally no experiments), 9: NPPs don' t experiment, but this is a major component of RR-inspection 14: Not applicable
Quality assurance	3	4, 6, 7, 8, 9, 12, 14, 15, 16	2, 5, 10, 11	1
Safety culture	3	4, 5, 6, 7, 8, 9, 11, 12, 14, 15, 16	1, 2, 10	(1: Becomes more important)

11* : Belgium indicated at the aspect "INSPECTION FOCUS" that the situation depends on the actual research reactor, hence sometimes two answers are given.

12 **: Total core calculation is done for Research Reactor’s, but core calculation for each fuel assembly is not done as at NPPs.

2***: Risk informed regulatory approach (relative risk in comparison with Nuclear Power Plants’s) is applied in all inspection focus items.

APPENDIX 2

Clarification by the US-NRC of the answers given at License requirements and regulator inspection.

On ISI:

The established surveillance programs have been determined to acceptably ensure safe operation at U.S. Research Reactors. In recognition of this fact and as part of the graded approach on U.S. Research Reactors, the NRC regulations have been established such that ISI is not required.

On (L)PSA:

The deterministic analyses used have provided a conservative yet an accurate picture of U.S. research reactor safety. Analyses are established for realistic or credible accidents scenarios. In recognition of this fact and as part of the graded approach on U.S. Research Reactors, the NRC regulations have been established such that PSAs are not required.

On grading material:

The commercial procurement processes at U.S. Research Reactors have been ensured acceptable safety. Because of this and the graded approach, the NRC regulations have not required a more formal procurement process at U.S Research Reactors.

On Monthly/Quarterly reporting of operation performance:

The NRC maintains regular communications through licensing operators, inspection and other regulatory activities with the licensees. Additionally, reporting mechanisms, for problems have been established. Further, NRC's enforcement policy encourages prompt reporting and resolution of problems by licensee. These processes have proved effective to ensure that licensees inform NRC of activities and safety concerns at the facility, and the concerns are promptly addressed.

On use of resident inspectors:

The inspection programme at U.S Research Reactors has ensured acceptable safety. Because of this and the graded approach, the NRC regulations have not required a resident inspector programme at U.S Research Reactors.

On same inspectors as at Nuclear Power Plants:

The NRC has found that inspectors specifically trained and familiar with U.S research reactor safety have been effective in ensuring safety at these facilities. Because the requirements are different from those for Nuclear Power Plants, this has been an important feature to ensure that the regulations are properly applied and that the safety of the facility is considered for specific facility and type.

Clarification of the answers given at "Inspection Focus"

General:

1) In Canada resource allocation for inspection of non-power reactors is risk-based. Up to now the risk-based approach was more qualitative than quantitative and depended on expert judgement. Starting in 2002 the compliance program planning adopted a more rigorous risk management approach. The current inspection frequencies are:

- Inherent safe reactors (20 kW): 1 inspection every two years, review their annual compliance report and conduct audits every few year.
- McMaster University reactor (5MW): inspection 3 times a year and assessed more often.
- MAPLE reactors (10 MW) and NRU reactor (135 MW): inspections 6 times a year and more scrutiny is applied.

2) Finland: STUK conducts regular annual inspections on e.g. reactor operation and instrumentation, physical protection, emergency exercises, radiation protection and fire protection. This regulatory process is principally the same than applied for nuclear power plants. The inspections at FiR 1 are simpler and typically shorter in time, because of smaller risks connected to the specific Triga Mark research reactor (250 kW thermal power, pool reactor, periodic reactor operation only short times e.g. one working day during a week) than those of power reactors.

10) Due to the fact that Switzerland’s only Research Reactor is a very small one (5 kW) the inspection focus is mainly less in the field of reactor- and system techniques with exception of criticality, radiation control, event reporting and good housekeeping. In the field of Quality Assurance and Safety Standards the inspection focus is more pragmatic.

License compliance:

4) Germany: Inspection philosophy in this area is the same as for Nuclear Power Plants.

7) Netherlands: Check on licence compliance (inclusive the technical specifications) because the Research Reactor don't have extensive programmes and instructions in which the requirements of the license are incorporated. Also manpower is less compared to Nuclear Power Plants which can cause violation of the license.

Good house keeping:

4) Germany: Safety orientated, research and experiment operation normally have no potential of radioactive contamination, and house-keeping in Research Reactor-process systems is inspected.

Operation performance:

4) Germany: Safety orientated, smaller nuclear risk than Nuclear Power Plants, less inspection amount, inspection philosophy in this area is the same as for Nuclear Power Plants.

7) Netherlands: As the inspection is carried out approximately 4 times a year the inspector is not that familiar with the operation of the Research Reactor. A global check is paid over the period between the inspections. Also the operation modes varies a lot, they depend on the experiments carried out.

Radiation control:

4) Germany: Inspection philosophy in this area is the same as for Nuclear Power Plants (doses to workers and public, radioactive releases).

7) Netherlands: More attention is paid to radiation control based on the same reasons as mentioned under license compliance. Most doses can occur when operators are handling an experiment.

Control maintenance performance:

4) Germany: Safety orientated, smaller nuclear risk than Nuclear Power Plants, smaller and less process systems and equipment than Nuclear Power Plants, less inspection amount, inspection philosophy in this area is the same as for Nuclear Power Plants.

5) Hungary: Less, because at Research Reactor only a small amount of safety system is present and they perform all of the tests and maintenance which is needed, although there are limited resources.

7) Netherlands: At Research Reactors only a small amount of safety systems are needed compared with Nuclear Power Plants's.

Witnessing Maintenance and Tests:

4) Germany: Safety orientated, smaller nuclear risk than Nuclear Power Plants, smaller and less process systems and equipment than Nuclear Power Plants, less inspection amount, inspection philosophy in this area is the same as for Nuclear Power Plants.

5) Hungary: Less, the maintenance program of Research Reactor are mainly routine activities. As there are no residence inspectors permanent inspection the maintenance and test program is not done; only at random

6) In Mexico, it is considered less witnessing maintenance and tests to Research Reactors is needed due to the fact that our research reactor is in operation one or two days per week, there is no severe environment and maintenance is carried out by operational personnel.

Control Test Performance:

4) Germany: Inspection philosophy in this area is the same as for Nuclear Power Plants, testing programme is part of the license requirements (safety specification).

6) Mexico: In Research Reactors are less safety systems than in a Nuclear Power Plants.

7) Netherlands: At Research Reactors only a small amount of safety systems are (needed?) present.

Witnessing tests:

4) Germany: Safety orientated, smaller nuclear risk than Nuclear Power Plants, smaller and less process systems and equipment than Nuclear Power Plants, less inspection amount, inspection philosophy in this area is the same as for Nuclear Power Plants.

Core calculations:

4) Germany: Inspection philosophy in this area is the same as for Nuclear Power Plants, less inspection work than for Nuclear Power Plants, special inspections and calculations as needed.

Criticality:

4) Germany: Inspection philosophy in this area is the same as for Nuclear Power Plants.

Event reporting:

4) Germany: Reporting requirements and procedure for Research Reactor same as for Nuclear Power Plants, reporting criteria are tailored to specifics of Research Reactor, reactive inspections after reportable events are as important as for Nuclear Power Plants's.

Assessment of experiments:

4) Germany: Conduct of experiments is licensed activity of the operator and within his responsibility, no nuclear risk involved, inspection and review by regulatory body only if safety related modifications of the licensed plant or its operation are involved for a planned experiment.

7) Netherlands: Experiments must be approved by the Regulatory Body in order to control possible influences of the experiment on the operation mode of the research reactor. Special attention is paid to possible criticality-effects (when using fissile materials in the experiment).

9) The NRC finds that experiments at U.S. Research Reactors are considerably more frequent and varied than Nuclear Power Plants. Experiments related to research and development are the prime business of U.S. Research Reactors and therefore where the NRC finds most the risk. Therefore the emphasis is in this area.

Quality assurance:

4) Germany: Inspection philosophy in this area is the same as for Nuclear Power Plants.

5) Hungary: The Research Reactors do not need contractors because mainly they carry out their activities themselves. Another point of view they have some lack of manpower and financial. In this way they have limited quality assurance program however this program is controlled by RB and fulfil the minimum requirements.

Safety culture:

4) Germany: Inspection philosophy in this area is the same as for Nuclear Power Plants.