

IAEA activities in the field of Research Reactors Safety

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Abstract

IAEA activities in the field of research reactor safety are included in the programme of the Division of Nuclear Installations Safety. Following the objectives of the Division, the results of the IAEA missions and the recommendations from International Advisory Groups, the IAEA has conducted in recent years a certain number of activities aiming to enhance the safety of research reactors. The following activities will be presented: (a) the new Requirements for the Safety of Research Reactors, main features and differences with previous standards (SS-35-S1 and SS-35-S2) and the grading approach for implementation; (b) new documents being developed (safety guides, safety reports and TECDOC's); (c) activities related to the Incident Reporting System for Research Reactor (IRSRR); (d) the new features implemented for the INSARR missions; (e) the Code of Conduct on the Safety of Research Reactors adopted by the Board of Governors on 8 March 2004, following the General Conference Resolution GC(45)/RES/10 ; and (f) the survey on the safety of research reactors published on the IAEA website on February 2003 and the results obtained.

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1- INTRODUCTION

The objective of the programme implemented by the Division of Nuclear Installation Safety (NSNI) of the Department of Nuclear Safety and Security of the IAEA is to achieve and maintain a high level of safety of nuclear installations under siting, design, construction or operating worldwide by: establishing standards of safety for the protection of health including standards for research reactors, nuclear power plants and other non-reactor installations; and providing for the application of these standards through, inter alia, support for the Agency's technical co-operation programme, the rendering of services, the promotion of education and training, the fostering of information exchange and the co-ordination of research and development.

Relating to Research Reactors, services are offered to Member States in the following areas: safety in the design and operation of research reactors (INSARR - Integrated Nuclear Safety Assessment of Research Reactor - missions); regulatory supervision of research reactors (IRRT - International Regulatory Review Team - missions); and experience feedback on safety issues for research reactors (IRSRR - Incident Reporting System for Research Reactors-database). Emphasis is also given to the development of new safety documents covering areas where there is a lack of guidance. Also efforts are done to review and update the old safety standards.

In 1998 the chairman of the International Nuclear Safety Advisory Group (INSAG) reported to the IAEA Director General the group concern about the safety of research reactors. INSAG has identified three major safety issues: the increasing age of research reactors; the number of research reactors that are not operating anymore but have not been decommissioned yet; and the number of research reactors in countries that do not have appropriate regulatory authorities.

In April 2000, INSAG (now appointed for its fifth term) reported again to the Director General. It stated, "While fully endorsing the concerns expressed by the previous INSAG, it must regretfully recognize that in spite of a prompt reaction by the Secretariat ... the problem remains very serious". The April 2000 letter repeated the issues raised in the earlier correspondence and also referred to a low level of safety culture surrounding many research reactors. While noting the efforts of the Secretariat, it stated "the Member States may as yet have realized neither the urgency of the issue nor the dimension of the problem." INSAG suggested the development of a Protocol to the Convention on Nuclear Safety or some similar legal instrument as a way of establishing a better international safety framework for research reactors. The General Conference GC(44)/RES/14 requested "the Secretariat, within its available resources, to continue work on exploring options to strengthen the international nuclear safety arrangements for civil research reactors, taking due account of input from INSAG and the views of other relevant bodies".

A Working Group (WG) was convened by the IAEA Secretariat as part of its response to the above GC resolution. The WG, consisting of 15 experts from 7 Member States, met in the Agency Headquarters in May 2001 to discuss options for an international arrangement on the safety of research reactors. The WG recommendations were submitted to the Board of Governors, which requested the Secretariat (GOV/2001/28-GC(45)/11-paragraph 18) to develop and implement, in conjunction with Member States, an international research reactor safety enhancement plan. The Board of Governors decision was endorsed by the General Conference GC(45)/RES/10. The plan includes the following elements:

- conduct a survey on research reactor safety in Member States;
- preparation of a Code of Conduct on the safety of research reactors with a view to establishing the desirable attributes for management of research reactor safety; and

- exploration of possible means to strengthen the system for monitoring the safety of research reactors, taking account of the experience of organizations working in other fields.

The activities implemented in the field of research reactor safety, by IAEA, Division of Nuclear Installation Safety, are addressed below.

2- SAFETY STANDARDS FOR RESEARCH REACTORS

Under the terms of its Statute, the Agency is authorized to establish or adopt standards of safety for the protection of health, life and property; and to provide for the application of these standards to its own operations as well as to other operations and, at the request of the parties, to operations under any bilateral or multilateral arrangement, or, at the request of a State, to any of that State's activities in the field of atomic energy [2].

The Safety Standards Series embodies an international consensus on objectives, concepts, principles, logic, methods and facts that is necessary to promote a common approach to ensuring safety in the peaceful applications of nuclear energy. They are categorized, as: (1) *Safety Fundamentals*; (2) *Safety Requirements* (3) *Safety Guides*. The categorization is intended to ensure that users of the safety standards are aware of the status and interrelationship of the various publications.

Besides the safety standards there are safety publications named Safety Reports and Technical Documents (TECDOC), which are descriptive reports on safety and protection in nuclear activities, describing good practices, practical examples and detailed methods of meeting safety requirements. They do not establish requirements or make recommendation and so they do not contain prescriptive "shall" or "should" statements.

Table 1 presents the Safety Documents for research reactors as well as more informational document on topics important to safety (the documents generated directly for research reactors application are typed in italic letter). The IAEA Publications are available on the website: <http://www-pub.iaea.org/MTCD/publications/publications.asp>

2.1- Safety Requirements of Research Reactors NS-R-4 (DS-272)

From 1997 to 1998 two Consultant Meetings and one Technical Committee Meeting were organized for developing and reviewing the Safety Requirements of Research Reactor NS-R-4 (formerly draft document DS-272). Comments from Member States were received and IAEA staff members prepared a final draft version in 2002. Most of the comments were implemented in a final draft version approved by NUSSC (Nuclear Safety Standard Committee) and by the CSS (Commission of Safety Standards) and is awaiting the approval by the Board of Governors (status at beginning September 2004).

NS-R-4 revises the two former safety standards of the IAEA Safety Series: No. 35-S1 and 35-S2. Besides updating the material, it places the publication within the new structure and categorization of the IAEA Safety Publications and updates its content to be consistent with the rest of the publications developed within the framework of the IAEA programme on research reactor safety.

The document covers all the important areas of research reactor safety with particular emphasis on requirements on design and operation. Pursuant requests from end-users, mainly from Member States with small nuclear programmes, to have a single and autonomous publication it also includes basic statements and requirements on regulatory supervision, management and verification of safety including quality assurance and site evaluation. These topics constitute the main differences from the new document to the previous standards. The

NS-R-4 applies to research reactors including critical facilities, but does not apply to sub critical facilities, prototypes, naval reactors, industrial reactors, heat generation reactors, etc. Research reactors are used for specific and varying purposes, e.g. research, training, radioisotope production, neutron radiography, material tests, etc, resulting in different design features and operational regimes. Design and operating characteristics may vary significantly since experimental devices may impact the performance of reactors. In addition, the need for greater flexibility in their use requires a different approach to achieving or managing safety. Considering the important differences between the different types of research reactors the application of the 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.

2.2- Safety Guides

Several new safety guides are under development:

- **DS259** - Commissioning of Research Reactors Safety Guide (**Published as working material**)-
- **DS260** - Maintenance, Periodic Testing and Inspections of Research Reactors Safety Guide (**Published as working material**)-
- **DS261** - Operational Limits and Conditions for Research Reactors Safety Guide and Operating Procedures (**OLCs was published as working material**)-
- **DS340** - Radiation Protection and Radioactive Waste Management in the Design and Operation of Research Reactors
- **DS325** The Operating Organization and the Recruitment, Training and Qualification of personnel for Research Reactors Safety Guide
- **DS350** - Core Management and Fuel Handling for Research Reactors Safety Guide

On the e IAEA website <http://www-ns.iaea.org/standards/documentpages/research-reactors.htm> are available information about those safety guides

2.3- Technical Reports and Documents (Safety Report Series and TECDOC Series)

Publications in the (numbered) Safety Reports Series may complement, and be directly related to, Safety Requirements or Safety Guides. They may give practical examples and detailed methods that can be used to ensure the compliance with Safety Requirements or Safety Guides. They may, for example, describe methods for performing certain calculations, illustrate types or form to be used in an auditing process, provide a compilation of data or describe methods for making a specific judgment concerning the fulfillment of safety requirements or recommendations. Safety Reports may describe good practices but they do not establish requirements or present recommendations and therefore they do not generally contain binding ‘shall’ or ‘should’ statements.

Owing to the experience and results of IAEA safety related missions to Member States’ research reactors there is a perception that additional information is needed to Operating Organizations and to Regulatory Bodies either to implement or to improve the application of the Agency Standards.

Efforts are done for further development of the following documents applicable to research reactors: Source-Term Derivation and Radiological Consequences Analysis for Accidents;; Safety Analysis; Safety Related Process and their Implications for OLCs [7], Implementation of a Management System for Operating Organizations of Research Reactors

On the IAEA web page: http://www-pub.iaea.org/MTCD/publications/PDF/te_1387_web.pdf is available the IAEA TECDOC Series No.1387 “Safety Considerations for Research Reactors in Extended Shutdown” is available.

Other links for publication on research reactors may be find on <http://www-ns.iaea.org/tech-areas/research-reactor-safety/default.htm#1>

3- INCIDENT REPORTING SYSTEM FOR RESEARCH REACTORS (IRSRR)

The systematic collection and evaluation of operational experience with unusual events is a very useful way to improve operational safety. A proper analysis of unusual events can identify root causes and provide valuable lessons to be learned by, for example, reactor operators or reactor designers [3].

The Incident Reporting System for Research Reactors (IRSRR) collects, maintains and disseminates reports on unusual events that are received from Member States of the IAEA participating in the system (this includes reports on unusual events that occurred before the IRSRR came into effect).

Participation in the IRSRR is voluntary and open to Member States that have a research reactor programme. The IAEA recommends that each Member State appoint a national coordinator (preferably from the regulatory body) and local coordinators (from operating organizations or constructors). Each coordinator should be a professional, knowledgeable with research reactors or should be assisted by such a professional.

The IRSRR is based on the principle that each participant will provide timely information on its experience with unusual events in research reactors so that the information is available to all other participants. Unusual events with safety significance or of general interest to the research reactor community should be identified by the national or local coordinators and transmitted to the IAEA. The IRSRR web based system is under operation and the access is available only for IRSRR co-ordinators (officially nominated by Member States) through the IAEA web page: <http://www.iaea.org/irsrr/>

Besides receiving, storing and distributing information, the IAEA prepares periodic reports on IRSRR activity and organizes periodic meetings to review and evaluate the material available on unusual events and invites lecturers to develop special subjects on each meeting. The last meeting of coordinators was held in November 2003 in Bariloche (Argentina), and the next meeting is scheduled for the 2nd quarter of 2005.

Until now 42 Member States jointed the IRSRR and the group represents more than 85% of the research reactors in the world. Nevertheless, the Agency was encouraged to continue to extend the number of participants to all Member States having research reactors.

4- INSARR MISSIONS

Although the IAEA has been carrying out safety reviews to research reactors since 1972 in order to meet the Member States' increasing requests for assistance to ensure and enhance research reactor safety, the IAEA announced in 1987 the creation of a more formal approach for providing this service. This approach was named Integrated Safety Assessment of Research Reactors (INSARR) [4]. In 1999 the INSARR methodology was modified to incorporate some of the features of the well-known Operational Safety Review Teams (OSART) service dedicated to power reactors, addressing recommendations provided during an external evaluation held in the year 1999. Following the new methodology, an INSARR Mission is constituted of three stages: Pre-INSARR, Main Mission and Follow-up.

The duration of the Main Mission is one week, but the number of team members depends on the reactor complexity and topics to be reviewed. A team leader and a deputy team leader

(both Agency staff) and a minimum of three external experts constitute the review team. Observers from organizations receiving an INSARR Mission in the future are invited to participate in the mission depending on the acceptance of the recipient country.

The main objective of INSARR missions is to conduct a comprehensive operational safety review of the research reactor facility and to verify compliance with the IAEA Safety Standards. However, an important spin-off from INSARR missions has been the mutual transfer of knowledge and experience between mission experts and reactor personnel and the development of self-assessment capabilities among the team members to be applied in their own countries. Certain missions have identified areas where the operating organization had developed a particularly good approach to certain safety topics, to the extent that the IAEA team recognized it as good practice and recommended it for application at other facilities.

The activities associated with a safety review cover a number of specific areas that depend on the objective of the review. However, the main areas to be examined during a safety review can be divided into four categories.

(a) *General*: nuclear regulations; regulatory supervision and licensing process; operating organization; reactor management and personnel training; quality assurance programme (QA); and emergency planning.

(b) *Nuclear Operational Safety*: safety analysis; safety analysis report (SAR); operational limits and conditions (OLC); operating procedures; maintenance and periodic testing; experiments and modifications; and conduct of operations including records and reports.

(c) *Radiation Protection*: radiation protection programme; waste management; airborne and liquid effluents; and radiological impact.

(d) *Special Issues* - which may consider unique topics such as: siting; design; construction; commissioning, major modifications; decommissioning; reactor ageing; and safety culture.

Topics such as design or safety culture are included in the area of special issues. In general, topics in this area require substantial effort and time from the reviewer. Therefore, these topics are not usually covered by typical INSARR missions, which focus on the topics in areas (a), (b) and (c).

The mission team designates issues for which it addresses either a recommendation or a suggestion. Good practices are also indicated.

The Follow-up Mission takes place no earlier than 12 months after the Main Mission. The scope of the Follow-up Mission is: evaluation of the safety improvements based on the recommendations provided at the final report; feedback from counterparts on the INSARR service and the means to improve it; preparation of a Follow-up Report.

The main areas in which recommendations have been done during recent INSARR mission were legal and regulatory supervision; operating organization and reactor management; training and qualification; safety analysis; OLC; QA; conduct of operation; maintenance and periodic testing; and emergency preparedness.

The benefit of Member States from the INSARR Mission may be concluded as: (1) Improvement of RR safety by the operating organization following the mission recommendations, suggestions and comments; (2) further Technical Assistance received from IAEA through TC Projects to help address certain safety issues identified during INSARR Missions; (3) Experience gained in performing safety assessment of research reactors by the experts, observers and the requesting operating organization.

5- CODE OF CONDUCT ON THE SAFETY OF RESEARCH REACTORS

The Board of Governors adopted the Code of Conduct on the Safety of Research Reactors at its March 2004 session. The Code is now before the General Conference with the recommendation that the Conference endorses it and call for its wide application. (Status at beginning of September 2004)

The Code is a non-binding, stand-alone, international legal instrument. Its purpose is to achieve and maintain a high level of safety in research reactors through enhancement of national measures and international cooperation.

The Code provides guidance to States on development and harmonization of policies, laws and regulations. The basic structure of the Code of Conduct is given by: scope, objective, implementation, role of the State, role of the Regulatory Body, role of the Operating Organization, and role of the IAEA. The technical provisions of the Code are based on international consensus documents, primarily IAEA Safety Fundamentals and Requirements.

The Code of Conduct includes recommendations on 'best practices' in management of research reactor safety and outlines the attributes of safety to be implemented in the site evaluation, design, construction, operation, utilization, modification, and decommissioning of a research reactor. Its three major sections identify the roles of the State, the Regulatory Body and the Operator. While the majority of the Code is drawn from requirements of the IAEA safety standard series, it focuses on current problematic issues such as reactors in extended shutdown or in need of improved ageing management. [5] (http://www-ns.iaea.org/downloads/ni/code-rr/code_conduct_March04.pdf)

6- SURVEY ON THE SAFETY OF RESEARCH REACTORS

Through resolution GC(45)/RES/10, the General Conference requested the Secretariat to conduct a survey on research reactor safety in Member States. The objectives of the survey are: to better characterise the status of safety at specific research reactors; to heighten Member States awareness and attention to potential safety issues; and to identify opportunities to apply existing modified or new Agency services and programmes to research reactor safety concerns.

A questionnaire comprising 15 questions covering topics on regulatory supervision, operational safety, radioactive waste management and emergency planning, was prepared and distributed to all the countries with research reactors independent of their status (planned, under construction, operational, shutdown or decommissioned).

By the end of 2002, 55 of the 67 Member States that have or plan to construct research reactors had responded for at least some of their reactors. These responses covered 233 reactors. From January 2003 to May 17, 2004 the Agency received additional responses from 5 Member States that had not previously reported so the total number of States responding is now 60. These new responses, plus one augmented response, cover in total an additional 18 reactors.

The Analysis of Responses to the IAEA Survey of Research Reactor Safety [6], as performed at the beginning of 2003, is available on the IAEA web page: <http://www-ns.iaea.org/downloads/ni/publications/asmtsrvy03.pdf>

Much of the concern for RR safety has been based on the number of reactors that are shutdown and not decommissioned. The safety assessment survey was designed in large part to better characterize the state of those reactors. The responses to the surveys indicate that a number of facilities that are categorized in the database as shutdown are in fact decommissioned or in the process of decommissioning.

7- CONCLUDING REMARKS

Research reactor safety is gaining in importance within the general scope of nuclear installation safety worldwide. The IAEA develops activities and offers various programmes to assist Member States in enhancing the safety of research reactors.

This paper outlined some of these activities and services performed recently on the area of Research Reactors Safety inside of Department of Nuclear Installation Safety.

8- REFERENCES

- [1] INTERNATIONAL ATOMIC ENERGY AGENCY, Safety of Research Reactors, International Conference on Topical Issues in Nuclear Safety, 3-6 September 2001, Vienna, Austria
- [2] INTERNATIONAL ATOMIC ENERGY AGENCY, Preparation and Review of Safety Related IAEA Publications, Version 2.2, October 1998
- [3] Guide on the Incident Reporting System for Research Reactors, January 2000
- [4] INTERNATIONAL ATOMIC ENERGY AGENCY, Safety Services No.1, Guidelines for the Review of Research Reactor Safety, December 1997
- [5] Code of Conduct on the Safety of Research Reactors – Adopted by the Board of Governors on 8 March 2004.
- [6] Analysis of Responses to the IAEA Survey of Research Reactor Safety – February 2003.
- [7] INTERNATIONAL ATOMIC ENERGY AGENCY, “Activities on Safety for the Cross-cutting Issue of Research Reactors in the IAEA” IGORR 9, 24-28 March 2003, Sydney, Australia

Table 1 – IAEA Documents on Research Reactor Safety

SAFETY FUNDAMENTALS
➤ THE SAFETY OF NUCLEAR INSTALLATIONS, SS No.110
➤ RADIATION PROTECTION AND THE SAFETY OF RADIATION SOURCES, SS No.120
➤ THE PRINCIPLES OF RADIOACTIVE WASTE MANAGEMENT, SS No.111-F
SAFETY REQUIREMENTS
➤ LEGAL AND GOVERNMENTAL INFRASTRUCTURE, GS-R-1
➤ PREPAREDNESS AND RESPONSE FOR A NUCLEAR OR RADIOLOGICAL EMERGENCY, GS-R-2
➤ INTERNATIONAL BASIC SAFETY STANDARDS FOR PROTECTION AGAINST IONISING RADIATION AND FOR THE SAFETY OF RADIATION SOURCES, SS No.115
➤ QA FOR SAFETY IN NPP AND OTHER NUCLEAR INSTALLATIONS, SS No.50 C/SG-Q
➤ PREDISPOSAL MANAGEMENT OF RADIOACTIVE WASTE INCLUDING DECOMMISSIONING, WS-R-2
➤ <i>CODE ON THE SAFETY OF NUCLEAR RESEARCH REACTORS: DESIGN</i> , SS No.35-S1
➤ <i>CODE ON THE SAFETY OF NUCLEAR RESEARCH REACT: OPERATION</i> , SS No.35-S2
➤ <i>SAFETY REQUIREMENTS FOR RESEARCH REACTORS, NS-R-4 (former DS 272), for publication (supersede SS 35-S1 and SS 35-S2)</i>
➤ <i>SITE EVALUATION FOR NUCLEAR FACILITIES, DS 305, for approval</i>
SAFETY GUIDES

- SAFETY ASSESSMENT OF RR AND PREPARATION OF THE SAR, SS No.35-G1
- SAFETY IN THE UTILIZATION & MODIFICATION OF RR, SS No.35-G2
- DECOMMISSIONING OF NUCLEAR POWER PLANTS AND RESEARCH REACTORS, WS-G-2.1
- DESIGN OF SPENT FUEL STORAGE FACILITIES, SS No.116
- OPERATION OF SPENT FUEL STORAGE FACILITIES, SS No.117
- ASSESSMENT OF OCCUPATIONAL EXPOSURE DUE TO EXTERNAL SOURCES OF RADIATION, RS-G-1.3
- ASSESSMENT OF OCCUPATIONAL EXPOSURE DUE TO INTAKES OF RADIONUCLIDES, RS-G-1.2
- REGULATORY CONTROL OF RADIOACTIVE DISCHARGES TO THE ENVIRONMENT, WS-G-2.3
- COMMISSIONING OF RESEARCH REACTORS, DS 259, **for approval**
- MAINTENANCE AND PERIODIC TESTING AND INSPECTIONS OF RR, DS 260, **for approval**
- OPERATIONAL LIMITS AND CONDITIONS FOR RESEARCH REACTORS, DS 261, **for approval**
- THE OPERATING ORGANIZATION AND THE RECRUITMENT, TRAINING AND QUALIFICATION OF PERSONNEL FOR RESEARCH REACTORS FACILITIES, DS 325, **for approval**
- OPERATIONAL RADIATION PROTECTION FOR RESEARCH REACTORS, **in preparation**

TECHNICAL REPORTS (Safety Report Series)

- SAFETY ASSESSMENT FOR SPENT FUEL STORAGE FACILITIES, SS No.118
- DEVELOPING SAFETY CULTURE IN NUCLEAR ACTIVITIES, Safety Report No.11
- CALIBRATION OF RADIOLOGICAL PROTECTION MONITORING INSTRUMENTS, Safety Report No.16
- INDIRECT METHODS FOR ASSESSING INTAKES OF RADIONUCLIDES CAUSING OCCUPATIONAL EXPOSURE, Safety Report No.18
- TRAINING IN RADIATION PROTECTION, Safety Report No.20
- SOURCE TERM DERIVATION AND RADIOLOGICAL CONSEQUENCES ANALYSIS FOR RESEARCH REACTOR ACCIDENTS, **in preparation**
- OPERATING PROCEDURES FOR RESEARCH REACTORS, **in preparation**
- SAFETY OF CORE MANAGEMENT AND FUEL HANDLING FOR RESEARCH REACTORS, **in preparation**
- INSTRUMENTATION & CONTROL, **in preparation**
- SAFETY OF NEW AND EXISTING RR FACILITIES IN RELATION OF EXTERNAL EVENTS, **in preparation**
- SAFETY ANALYSIS FOR RESEARCH REACTORS, **in preparation**
- SAFETY RELATED PROCESSES AND THEIR IMPLICATIONS FOR OLCs, **in preparation**

TECHNICAL DOCUMENTS (TECDOC Series) and others

- SITING, TECDOC-403
- EARTHQUAKE RESISTANCE, TECDOC-348
- GUIDELINES FOR THE REVIEW OF RESEARCH REACTOR SAFETY, Services Series No.1
- AGEING MANAGEMENT, TECDOC-792
- EMERGENCY RESPONSE PREPAREDNESS FOR NUCLEAR OR RADIOLOGICAL ACCIDENTS, TECDOC-953

- COMPARISON BETWEEN IAEA 50-C/SG AND ISO 9001:1994, TECDOC-1182
- *CORE CONVERSION, TECDOC-233, TECDOC-643*
- *MTR FUEL, TECDOC-467*
- *GENERIC COMPONENT RELIABILITY DATA FOR RESEARCH REACTOR, TECDOC-930*
- RELIABILITY DATA, TECDOC-636
- PSA, TECDOC-400, TECDOC-517
- *APPLICATION OF NON-DESTRUCTIVE TESTING AND IN-SERVICE INSPECTION TO RR, TECDOC-1263*
- EXTENDED SHUTDOWN TECDOC - 1387
- *INSARR MISSION RESULTS, working material*
- *EXPERIENCE W/ ACCIDENTS 1999, working material*
- *EXPERIENCE W/ ACCIDENTS 2000, working material*
- *PLANNING AND MANAGEMENT FOR THE DECOMMISSIONING OF RESEARCH REACTORS AND OTHER SMALL NUCLEAR FACILITIES -TRS No. 351*
- *DECOMMISSIONING TECHNIQUES FOR RESEARCH REACTORS, TRS No. 373*
- *DECOMMISSIONING TECHNIQUES FOR RESEARCH REACTORS- CRP REPORT, TECDOC-1273*