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American National Standard for Decommissioning of Research Reactors

Secretariat
American Nuclear Society

Prepared by the
**American Nuclear Society
Standards Committee
Working Group ANS-15.10**

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Foreword

(This Foreword is not a part of American National Standard for Decommissioning of Research Reactors, ANSI/ANS-15.10-1994, but is included to provide a background and explain the need for non-power reactor standards and criteria concerning the use of those standards.)

The American Nuclear Society Standards Secretariat established Subcommittee ANS-15 in the fall of 1970 with the task of preparing a standard for the operation of research reactors. In January 1972, this charter was expanded to the multiple tasks of preparing all standards for research reactors. To implement this enlarged responsibility, several subcommittee working groups were established to develop standards for consideration, and complementary action by Subcommittee ANS-15. ANS-15.10 is one of these groups.

In March 1979, Working Group ANS-15.10 was assigned the task of developing a draft standard for decommissioning of research reactors. Since that time changes in regulatory policy were incorporated into this current revision.

Present decommissioning regulations for reactors are contained in Title 10, "Energy," Code of Federal Regulations, Part 50, "Licensing of Production and Utilization Facilities," which addresses primarily the financial qualifications of the applicants. The policy for licensed power reactors is contained in U.S. Nuclear Regulatory Commission (NRC) Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors," which was issued in June 1974 and is generally used as a basis for decommissioning activity. Currently, the NRC is in the process of developing more specific criteria through an enhanced participatory rulemaking process designed to establish radiological criteria for the decommissioning of NRC-licensed facilities. Section 5 in general and Table 5.2 in particular are presented as the best available criteria that are reasonable and acceptable, but subject to change as further focused analysis is completed. This standard provides needed procedures, criteria, and standardization for the decommissioning of research reactors; the standard which is also appropriate for test reactors.

As a caution, because of the current developmental activity by the NRC in this area, it should be recognized that some of the procedures and criteria stated in this standard are not based on existing regulations, and that as regulations are developed and approved, such procedures and criteria may be subject to change.

In preparing this standard, the intent has been to specify objectives that will:

- (a) Assist in implementing regulatory requirements.
- (b) Be a significant aid in planning and executing decommissioning activities.

The family of American National Standards developed by ANS-15 for research reactors includes the following:

- ANSI/ANS-15.1-1990, American National Standard for the Development of Technical Specifications for Research Reactors
- ANSI/ANS-15.2-1990, American National Standard for Quality Control for Plate-Type Uranium-Aluminum Fuel Elements
- ANSI/ANS-15.4-1988, American National Standard for Selection and Training of Personnel for Research Reactors
- ANSI/ANS-15.7-1977 (R1986), American National Standard for Research Reactor Site Evaluation
- ANSI/ANS-15.8-1976 (R1986), American National Standard for Quality Assurance Program Requirements for Research Reactors
- ANSI/ANS-15.11-1993, American National Standard for Radiation Protection at Research Reactor Facilities
- ANSI/ANS-15.15-1978 (R1986), American National Standard Criteria for the Reactor Safety Systems of Research Reactors
- ANSI/ANS-15.16 (R1988), American National Standard for Emergency Planning for Research Reactors
- ANSI/ANS-15.17 (R1987), American National Standard Fire Protection Program Criteria for Research Reactors
- ANSI/ANS-15.19-1991, American National Standard for Shipment and Receipt of Special Nuclear Material (SNM) by Research Reactor Facilities

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Decommissioning of Research Reactors

1. Scope

This standard provides requirements and criteria for the decommissioning of research reactors and includes decommissioning alternatives, planning, radiation criteria, surveillance and maintenance, environmental impacts, quality assurance, and reports and documentation.

2. Definitions

as low as is reasonably achievable (ALARA). To make every reasonable effort to maintain exposures to radiation as far below the dose limits as is practical, consistent with the purpose for which the permitted or licensed activity is undertaken, taking into account the state of technology, the economics of improvements in relation to the benefits to the public health and safety, and other societal and socio-economic considerations, and in relation to the utilization of nuclear energy and permitted or licensed materials in the public interest.

decommissioning. The measures taken at the end of the reactor facility's life to remove radioactive material to acceptable levels so as to terminate the license or operating authorization. For the scope of this standard, only the special nuclear, source, and byproduct materials are covered. All other hazardous substances should be handled in accordance with standard industry procedures, guidelines, or requirements.

non-power reactor (NPR). See research reactor.

research reactor. A device designed to support a self-sustaining neutron chain reaction for research, developmental, educational, training, or experimental purposes, and that can have provision for production of radioisotopes.

NOTE: For the purposes of this standard, test and non-power reactors fall within this definition.

research reactor facility. All areas within which the owner or operator directs authorized activities associated with the reactor.

shall, should, and may. The word "shall" is used to denote a requirement; the word "should" to denote a recommendation; and the word "may" to denote permission, neither a requirement nor a recommendation.

test reactor. See research reactor.

unrestricted use. The use of a facility, material, equipment, or waste when the radioactive content on surfaces of or inherent within any portion of it is sufficiently low to pose no unacceptable health hazard to any individual or group of individuals regardless of any future use or location of the facility, material, equipment, or waste.¹

3. Decommissioning Alternatives

The ultimate abandonment of a reactor facility upon completion of operations will require either (1) the retention of certain radioactive materials *in situ*, or (2) the removal of radioactive materials to acceptable levels from the facility to an approved disposal site. Retention of materials *in situ* will require continuation of a license or charter and does not complete a decommissioning alternative. Three major recognized decommissioning alternatives leading to the ultimate disposition are interim mothballing, in-place entombment, and removal of radioactive components and dismantling;² see *Decommissioning Handbook* [1].³ The acronyms SAFSTOR, ENTOMB, and DECON are

¹Unrestricted use addresses only health hazards and not potential industrial uses which might be impacted by low radioactivity, e.g., sensitive radiation detectors.

² See Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors" (June 1974). Regulatory guides are available from the U.S. Nuclear Regulatory Commission, Washington, DC 20555.

³ Numbers in brackets refer to corresponding numbers in Section 10, References.

used herein to identify the three recognized alternatives respectively.⁴ A decommissioning plan as specified in this standard shall be prepared by the owner and approved by the licensing or chartering agency. Decommissioning should be accomplished without significant delay unless such delay is necessary to protect public health and safety. This may mean that DECON may be the only acceptable alternative for a research reactor. Finally, the principles of ALARA must be applied in decommissioning regardless of which of the following three alternatives is selected.

3.1 SAFSTOR. SAFSTOR means to defer decommissioning for a period of storage during which the facility is maintained so that the risk to public health and safety is acceptable. The duration of the SAFSTOR storage period depends on several factors, including the structural condition of the facility; the lifetimes of the residual radionuclides; the present and future use of the facility or site, or both; and the cost of the security/maintenance/surveillance program. Passive protection techniques should be employed to the maximum extent practical in SAFSTOR. The present and future use of the facility or site includes the consideration that with continuing use of radioactive materials at the facility or site, SAFSTOR may provide an opportunity to develop an integrated decommissioning plan for the entire site that could be more efficient and cost-effective. Another SAFSTOR consideration is that during this protective storage period, decay of the shorter life radionuclides occurs, which naturally reduces the dose to future decommissioning personnel. The use of SAFSTOR shall be consistent with ALARA principles. A major ALARA consideration under SAFSTOR may be the storage and disposition of reactor fuel at the facility, in an independent spent fuel storage installation, or its final disposal. Following the protective storage period of SAFSTOR, the facility ultimately must be decommissioned as discussed in 3.2, ENTOMB, or 3.3, DECON. Protective storage via SAFSTOR shall include the following actions, with appropriate documentation:

- (1) Performance of a comprehensive characterization survey for radioactive materials (see 4.3.2).
- (2) Removal of all fuel assemblies from the facility.
- (3) Removal of radioactive fluids and wastes from the reactor.
- (4) Removal or stabilization of contamination in all facility areas. Included in this are measures to prevent the spread of contamination during the protective storage period.
- (5) Operation of all required life support and protection systems, i.e., heating, ventilation, air conditioning, radiation monitoring, fire protection, and environmental monitoring, as appropriate.
- (6) De-energizing of non-required systems.
- (7) Isolation and access control of remaining radioactive areas.
- (8) Definition and performance of routine access control/security, maintenance, and surveillance activities. After nuclear fuel is removed from the site, locked closures and intrusion alarms may constitute adequate security.

3.2 ENTOMB. In-place entombment (ENTOMB) consists of sealing all of the remaining highly radioactive or contaminated components (e.g., reactor structural components) within a structure integral with the biological shield, after removal of all fuel assemblies, all radioactive fluids and wastes, and certain selected components. The structure should provide integrity over the period of time during which significant quantities (greater than Table 5-1 levels) of radioactivity remain with the material in the entombment. ENTOMB may not be possible for a reactor facility that has had a significant operating history, due to the presence of long-lived activation products or fission products in the reactor. The time before unrestricted release of material can be permitted may be inordinately long, and structural integrity of the entombment may not be assured over that period. The use of the ENTOMB alternative must be consistent with the principles of ALARA. ENTOMB shall include the following actions, with appropriate documentation:

- (1) Performance of a comprehensive characterization survey for radioactive materials (see 4.3.2).

⁴ Appendix A presents a summary of terminologies used in various places to define decommissioning alternatives.

- (2) Removal of all fuel assemblies from the facility.
- (3) Removal of radioactive fluids and wastes from the facility.
- (4) Removal or stabilization of contamination in all areas. Included in this are actions to prevent the spread of contamination during the protective storage period.
- (5) Sealing of the remaining reactor components that can include use of the existing structure.
- (6) Performance of routine security, maintenance, and surveillance activities.
- (7) Operation of necessary monitoring systems (e.g., radiation, fire, security, and environmental).
- (8) Final survey.
- (9) Gaining of authorization for unrestricted use from the cognizant licensing or chartering agency or agencies.

3.3 DECON. The removal of radioactive components and subsequent dismantling, an alternative called DECON, consists of removal of fuel assemblies, radioactive fluids, waste, and other materials having activities above accepted unrestricted activity levels (see Table 5-1) consistent with the principles of ALARA. This alternative shall include the following actions, with appropriate documentation:

- (1) Performance of a comprehensive characterization survey for radioactive materials (see 4.3.2).
- (2) Removal of all fuel assemblies from the facility.
- (3) Decontamination of structural surfaces to allow unrestricted access to the facility.
- (4) Removal from the facility of radioactive material which would prevent unrestricted use of the facility.
- (5) Final survey.
- (6) Gaining of authorization for unrestricted use from the cognizant licensing or chartering agency or agencies.

The facility owner may then have unrestricted use of the site. If the owner so desires, the remainder of the reactor facility may then be dismantled and all vestiges removed for disposal.

4. Planning

Planning for decommissioning of research reactors should begin during the facility design period. This planning should be implemented during construction and operation, to facilitate decommissioning feasibility and minimize occupational dose and overall cost. Such planning should anticipate the need for additional data, shielding, decontamination, and waste handling and disposal, and also anticipate site and facility access, and the principle of ALARA.

For existing operating reactors, decommissioning planning should be included in the design of major facility modifications. For these reactors, preparatory decommissioning work, including the ordering of special tools or equipment and the collection of reliable facility and site data, should be planned and implemented during the operating period.

Financial planning for ultimate decommissioning of a research reactor should be considered during both the design and operating phases to ensure availability of adequate funds when they are needed.

4.1 Design Period Planning. In designing a research reactor, the architect-engineer should consider the requirements for facility decommissioning. The following discussion identifies certain areas where designers can simplify dismantling activities.

4.1.1 Occupational Exposure. The design of the systems and structure shall include consideration of means for maintaining occupational radiation exposure ALARA. For highly radioactive components, techniques such as the use of radiation shields, rapid disassembly design, remote chemical decontamination connections, and space adequate for cutting and removal should be included.

4.1.2 Accessibility. The facility design shall include sufficient platforms, doors, passageways, cranes, portable hoist supports or rails, lighting, and power supplies (pneumatic and electrical) in potentially high dose rate areas to allow work to be done with the radiation dose ALARA.