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Informal Report**

**REGULATIONS, GUIDELINES, STANDARDS, AND POLICIES
PERTAINING TO DECONTAMINATION AND DECOMMISSIONING
ACTIVITIES: A LITERATURE REVIEW**

INFORMAL REPORT

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ABSTRACT

A literature review of the existing rules, regulations, and guidelines pertaining to the decontamination and decommissioning of nuclear facilities has been updated. Included in the survey are U.S. Government documents, national (industrial) standards, international standards and guidelines, and the regulations issued by various national governments, such as the United Kingdom, Canada, and Germany.

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1. INTRODUCTION

The Department of Energy (DOE) complex contains within it almost 1,000 nuclear facilities which will require decommissioning in the coming years [Murphie 1992]. This action will entail activities in many different areas, one of which will involve the development of the basic safety principles to be applied to the process as a whole. These principles will be used to guide personnel in the development of safety assessment procedures for decontamination and decommissioning (D&D) activities and in conducting safety assessments of such activities at the facilities themselves.

Development of the principles will be based, in part, on information obtained during past D&D operations at DOE and other facilities, both in the U.S.A. and in other countries. In the U.S.A., nuclear facilities are found in basically three sectors - the military, the civilian and the DOE. D&D has taken place, and continues to take place, in all three but detailed information on the military sector operations is not readily available. Thus for the present task, attention was focused on the sets of safety guidelines that exist for D&D of DOE facilities and those applicable to civilian operations. In addition, a survey has been made of the safety-related regulations and guidance issued by international organizations and by individual foreign countries.

The present report represents an updating of the original report [Cowgill 1993]. It retains all the information that appeared in the original report with the new material integrated into the applicable sections. Future revisions will be made as additional information becomes available.

2. U.S. GOVERNMENT RULES, REGULATIONS, AND GUIDELINES

The U.S. Government has in place and under development many rules, regulations and guidelines which impact, directly or indirectly, on D&D activities at nuclear facilities and the safety therein. The various Departments of the Federal Government have also issued standards to be used in the conduct of their business (e.g., MIL standards, for use in the development and manufacture of military components). These may be used during D&D activities but, for the purpose of this review, are considered ancillary standards which do not determine the overall D&D process or impact directly the operations that have to be performed.

The general rules and regulations developed by the various departments and agencies of the Federal Government appear first in the Federal Register (FR) and are later codified in the Code of Federal Regulations (CFR). The Code itself is divided into 50 titles which are representative of the broad areas subject to Federal regulation. Each title is divided into chapters bearing the name of the issuing agency, then subdivided into parts covering specific areas of regulation. The titles which have most direct relevance to D&D activities are Title 10 (Energy), Title 29 (Labor), Title 40 (Protection of the Environment) and Title 49 (Transportation). Within Title 10, Parts 1 through 199 are the regulations issued by the Nuclear Regulatory Commission (NRC). The remaining Parts (200 to the end) of Title 10 are reserved to the rules and regulations of the DOE but it should be noted that very few of these Parts discuss the nuclear-centered activities which comprise a large portion of the agency's overall operations.

Examples of titles and their parts which should be consulted if D&D of a nuclear facility is contemplated are:

10 CFR 20	(Standards for Protection Against Radiation)
10 CFR 30	(Rules of General Applicability to Domestic Licensing of Byproduct Material)
10 CFR 40	(Domestic Licensing of Source Material)
10 CFR 50	(Domestic Licensing of Production and Utilization Facilities)
10 CFR 51	(Environmental Protection Regulations for Domestic Licensing and Other Regulatory Functions)
10 CFR 61	(Licensing Requirements for Land Disposal of Radioactive Waste)
10 CFR 70	(Domestic Licensing of Special Nuclear Material)
10 CFR 71	(Packaging of Radioactive Material for Transport and Transportation of Radioactive Materials Under Certain Conditions)

10 CFR 72	(Licensing Requirements for Storage of Spent Fuel in an Independent Spent Fuel Storage Installation)
10 CFR 835	(Radiation Protection of the Public and the Environment)
10 CFR 1021	(National Environmental Policy Act Implementing Procedures)
29 CFR 1910	(Occupational Safety and Health Administration)
40 CFR 61	(National Emission Standards for Hazardous Air Pollutants)
40 CFR 190	(Environmental Radiation Protection Standards for Nuclear Power Operations)
40 CFR 191	(Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High Level Waste and Transuranic Waste)
40 CFR 192	(Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings)
49 CFR 170 through 49 CFR 190	(Hazardous Materials Regulations)

Regulations such as the above are already in place but are under continual review and revision. In addition, there exist proposed rules that may be of relevance to the current discussion; for example, 40 CFR 194 (Radiation Protection Criteria for Cleanup of Land and Facilities Contaminated with Residual Radioactive Material). These proposed rules, together with proposed changes to existing regulations, have been (and will continue to be) published in the Federal Register (FR) and comments requested.

Individual departments in the Federal Government issue their own orders, guidance and clarification documents on specific subject areas arising from the general Federal rules and regulations appearing in the CFR.

2.1 Department of Energy

The main DOE document DOE which addresses D&D is DOE Order 5820.2A, issued September 26, 1988 [DOE 1988]. Chapter V deals solely with the decommissioning of radioactively contaminated facilities and lists the requirements associated with the implementation of decommissioning programs. These include the full characterization of the structures and materials involved, the conduct of environmental reviews, a description of the engineering planning for the project, the conduct of the decommissioning operations and the post

decommissioning activities. DOE 5820.2A does not prescribe any quantitative limits related to such aspects as residual surface contamination and occupational exposure limits, the latter of which are to be found in DOE 5480.11 (Radiation Protection for Occupational Workers). DOE 5820.2A is currently being revised and the draft section on decontamination and decommissioning of radioactively contaminated facilities is under review.

The DOE has also issued a Radiological Control (RadCon) Manual, DOE N 5480.6, [DOE 1992], the purpose of which is to present the DOE's radiological control program and establish the framework for implementation. In the event of conflict between a provision of the RadCon Manual and a provision of another DOE Order (e.g., DOE 5480.11), the RadCon Manual provision supersedes the other provision or specific exemption or waiver should be sought. Within the RadCon Manual itself, Chapter 3 makes specific reference to decommissioning work. This chapter, entitled Conduct of Radiological Work, covers aspects such as planning, work preparation, area entry and exit requirement, radiological work controls, and construction and restoration projects (including D&D). Other chapters also contain information which would be applicable to D&D work. Chapter 2, Radiological Standards, lists the various administrative control levels and dose limits, and surface contamination limits. Chapter 5, Radiological Health Support Operations, describes, among other items, how personnel will be monitored to enable compliance with the limits. On a different aspect of D&D operations, Chapter 4, Radioactive Materials, includes description of the procedures associated with release of radioactive materials to controlled and uncontrolled areas (the criteria for release to the latter are described in DOE 5400.5).

In addition to the DOE, the Department's contractors often develop their own procedures and manuals. These manuals are not always available for public dissemination but information contained in them can sometimes be located in reports and papers. For example, Hine, in reporting on the D&D of the SPERT-II and SPERT-III reactors [Hine 1981], reproduces the criteria used by EG&G Idaho Inc. for the release of a facility for unrestricted use. The information itself was taken from EG&G's safety manual for its radiation contamination control program [EG&G 1978].

D&D activities at DOE facilities are also becoming increasingly subject to regulations arising from the need to comply with such as the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), the Resource Conservation and Recovery Act (RCRA), the Toxic Substances Control Act (TSCA) and the National Environmental Policy Act (NEPA) [DeLozier 1992], [Houlberg 1994], [DOE 1994]. In concert with these actions, agreements have been signed with appropriate state governments to provide for oversight of D&D activities. Houlberg and Etnier point out that, particularly with relevance to CERCLA, compliance with these acts has given rise to the concept of ARARs, "legally applicable or relevant and appropriate requirements," the implications of which are discussed in some detail in [Houlberg 1994].

2.2 Nuclear Regulatory Commission

D&D activities in the civilian sector are regulated by the NRC has issued several documents.

Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors" [NRC 1974], was issued in June 1974 and continues in use to this day. It provides guidance on several aspects associated with license termination, including what information to include when filing an application, what alternatives for retirement of a nuclear facility are acceptable to the NRC, the associated surveillance and security requirements, and reactor retirement procedures. There is also discussion of decontamination of a facility so that it may be released for unrestricted use and a table is provided of acceptable surface contamination levels. As discussed in [Wynveen 1985], these surface contamination limits were taken from a proposed draft of an American National Standards Institute (ANSI) standard, N328, which was never issued.

Regulatory Guide 3.65, on the format and content of decommissioning plans for nuclear facilities, was issued in August 1989 [NRC 1989] and provides indications of the actions expected of a licensee who plans to decommission such a facility. The plans should include discussion of the decommissioning alternative selected, the activities involved, the facility radiological status (past and current), radiation protection, radioactive waste management, accident analyses and the final radiation survey plan.

Another Regulatory Guide, 8.8, does not specifically address decommissioning of a nuclear facility but is nonetheless thought to be relevant to such operations [NRC 1978a]. This particular document provides guidance on ensuring that occupational radiation exposures at nuclear power stations is kept as low as is reasonably achievable (ALARA).

Other NRC documents related to decommissioning rules and regulations include "Manual for Conducting Radiological Surveys in Support of License Termination" [Berger 1992] and "Residual Radioactive Contamination from Decommissioning" [Kennedy 1992]. Neither report provides numerical information concerning acceptable levels of activity and surface contamination but refers to extant criteria (such as Regulatory Guide 1.86).

The NRC is continually reappraising its regulatory position relative to the decommissioning of nuclear facilities. Such efforts have been in place since the late 1970s [Stello 1980] and a plan to reevaluate the NRC policy in this regard was issued in 1978 [NRC 1978b]. Several studies were initiated at about the same time to develop information to support the preparation of new and/or revised decommissioning standards. The results included a series of reports on the technology, safety and costs of decommissioning various types of nuclear facilities (for example, nuclear reactors at multiple-reactor stations [Wittenbrock 1982]) and a comprehensive bibliography [Konzek 1978] (it should be noted that the DOE also produced a selected bibliography at about the same time - see [Faust 1980]). As part of the effort, Schilling et al. [Schilling 1979] produced a comprehensive review and analysis of the regulations current at that time. The authors looked at both those requirements (statutes, regulations, guidelines and standards) which specifically addressed decommissioning and those generic standards (for example, transportation) which might be applicable to decommissioning activities. Conti [Conti

1980] has described some results obtained during the development of residual radioactivity criteria. An later, updated analysis of the regulatory environments surrounding decommissioning of commercial nuclear power plants was provided by Cantor [Cantor 1986]. The purpose of his study was to identify some of the trends in regulations and regulatory practices that would significantly affect the costs, technical alternatives and financing schemes associated with such projects. There is some discussion of the technical aspects and the factors which influence the selection of the method of decommissioning, including residual radioactivity levels and occupational exposure doses. However, the report is mostly concerned with analyzing the costs and funding needs associated with the various scenarios and technical alternatives.

The information collected in the reevaluation program were used extensively in the production of a generic environmental impact statement concerning decommissioning of nuclear facilities [NRC 1988]. This comprehensive document discusses generic nuclear facility decommissioning considerations, including decommissioning alternatives, residual radioactivity levels for unrestricted use, financial requirements and waste management issues. The report addresses in detail the decommissioning of more than a dozen types of nuclear facilities, in each case comparing the decommissioning alternatives available based on radiation safety, costs and environmental consequences. The final section of the report reviews the policy considerations before the NRC and major regulatory aspects, and makes recommendations concerning essential regulatory actions.

Incentive, if needed, to continue the reevaluation program came with the issuing of a report by the U.S. General Accounting Office (GAO) [GAO 1989]. In addition to pointing out instances of apparently poor regulatory oversight, the GAO highlighted the fact that "no federal standards exist for acceptable levels of radiation that can remain after the NRC terminates a license. As a result, licensees are using NRC guidance developed in the early 1970s to decommission their facilities."

[Martin 1992] provides a synopsis of the regulations established in 1988 together with a status report on the dozen power reactors shut down at that time and in various stages of decommissioning. In it, Martin describes and discusses factors such as acceptable decommissioning alternatives, the need to prepare a Preliminary Decommissioning Plan and what it should include, certification of financial assurance, recordkeeping and cleanup criteria. In the last category, he cites not only the existence of Regulatory Guide 1.86 but also a second, ad hoc, standard (for gamma radiation) that has evolved out of repeated use over the years on a case-by-case basis. However, it is pointed out that the NRC has in place a program for updating these criteria.

At the present time, the NRC is pursuing a more consultative approach to rulemaking [Cameron 1992; Kovach 1992] and has recently completed a series of workshops to develop a proposed rule on radiological criteria for the decommissioning of NRC-licensed facilities. The workshop discussions, announced in the Federal Register (57 FR 58727, December 11, 1992), used as a focal point a Rulemaking Issues Paper which treats both the objectives for developing radiological criteria and the application of practicality considerations. The outcome of the

workshops and the proposed rule were published in the Federal Register (59 FR 43200, August 22, 1994). The key provision in the proposed rule is that decommissioned sites will be considered acceptable for unrestricted release if the residual radioactivity that is distinguishable from background radiation results in a total effective dose equivalent not in excess of 15 mrem/y (0.03 mSv/y). The NRC is continuing in a similar vein in other areas, such as site characterization, and is in the process of completing several Branch Technical Position (Austin 1994).

2.3 Environmental Protection Agency

As with the NRC, the Environmental Protection Agency (EPA) is in the process of developing and establishing standards applicable to D&D activities. Crofford [Crofford 1980] provides an early overview of the EPA's plan in this area. Among the items he discusses, in general terms, are the need to review existing standards, regulations and criteria, the costs associated with decommissioning, the need for financial provisions, and occupational radiation protection. Lichtman and Ronca-Battista, in [Lichtman 1985] and [Lichtman 1986], provide a later discussion of developments at the EPA concerning residual radioactivity criteria. The authors describe efforts on a pathway analysis which relates residual radioactivity levels to doses to such as on-site individuals and also the compilation of an inventory of site and facility characteristics (more details on the latter can be found in [Ronca-Battista 1985]).

[Voillequé 1985] reviewed the radiation protection guidance in existence in 1985 and that anticipated, covering the activities and actions of the International Commission on Radiological Protection (ICRP), the National Council on Radiation Protection and Measurements (NCRP), the EPA, the NRC, the DOE and other groups. The ICRP and NCRP provide recommendations and guidance on radiation protection, the adoption of which is left up to the individual national and international legislative bodies. Voillequé describes how these recommendations are derived and what their values are. There is also discussion of the "de minimis" concept and the author places much emphasis on possible misconceptions about what it represents. A more in-depth discussion of the "de minimis" radiation dose, including a tabulation of dose recommendations of numerous national and international agencies, can be found in [Kocher 1985]. "De minimis" dose limitation is similar to, but not quite the same as, the "below regulatory concern" policy proposed by the NRC in 55 FR 27522, July 3, 1990, but later withdrawn.

The current EPA program to develop regulations for radiation site cleanup has been summarized by Burnett [Burnett 1994]. The author mentions that the Agency is also developing regulations that will address the management of radioactive waste generated during site remediation and exploring the feasibility of recycling/reusing structures, equipment and materials after cleanup. The EPA is coordinating these efforts with all interested parties, including other Federal agencies, and will be providing opportunities for public involvement during the rulemaking. Among approaches being considered are the establishment of an acceptable level of risk (or range of risks) and the development of tables of maximum concentrations of radionuclides.

3. NATIONAL (INDUSTRIAL) STANDARDS

Standards applicable to the decommissioning of nuclear facilities have been developed, or are in the process of development, by various professional societies. These include the American Society for Testing and Materials (ASTM), the American Nuclear Society (ANS), the American Society of Mechanical Engineers (ASME) and the Health Physics Society (HPS). Some of the activities of these societies are described in [Steffes, 1988].

The ASTM has issued several standards which are relevant to D&D operations. These include:

- E 1281 (Nuclear Facility Decommissioning Plans) [ASTM 1989]
- E 1278 (Radioactive Pathway Methodology for Release of Sites Following Decommissioning) [ASTM 1988]
- E 1167 (Radiation Protection Program for Decommissioning Operations) [ASTM 1987a]
- E 1168 (Guide for Radiological Protection Training for Nuclear Facility Workers) [ASTM 1987b]
- E 1034 (Nuclear Facility Transient Worker Records) [ASTM 1985]

The scope of ASTM E 1281 applies to the decommissioning plans for any nuclear facility, including those whose operation is governed by NRC or Agreement State license or is under DOE orders. It identifies the elements which should be included in a decommissioning plan, provides a list of activities which might typically be associated with decommissioning a facility and indicates some of the documentation which might be necessary to support a decommissioning program.

The stated purpose of ASTM E 1278 is "to provide guidance in determining site-specific conversion factors for translating between dose limits and residual radioactive contamination levels on equipment, structures and land areas." It does not endorse specific levels of allowable residual contamination and points out that such standards are not yet available for all types of nuclear facilities. An extensive section of the guide is devoted to pathway analysis and covers pathway analysis objectives, site-specific pathway analyses, and the basis and methods of calculating pathway doses, including a diagram showing potential pathways that could result in off-site doses.

ASTM E 1167 defines and discusses elements that should be addressed in a radiation protection plan for a decommissioning project. These include radiation safety organization and responsibilities, radiological control areas, sources and types of radiation, radiological survey plans, ALARA programs, external and internal radiation exposure control, and decontamination. Although the guide discusses radiological release criteria, it does not provide any specific details, stating only that they "should be based upon applicable limits for unrestricted release." The Appendix to the guide provides an extensive list of general references and related standards.

ASTM E 1168 is directed toward the provision of appropriate training for workers in radiologically controlled areas in nuclear facilities. Such training programs are particularly pertinent for operational facilities but they are also of relevance when a facility is being decommissioned. The guide provides detailed guidance on how to administrate such a program and addresses the many topics which should be included in the training program.

D&D activities will probably involve workers being employed temporarily at several sites over time and this brings about a concern regarding adequate monitoring of the cumulative radiation doses of individual workers. ASTM E 1034 describes the required content of records needed for processing such personnel. These include information on the occupational radiation exposure for the current quarter and the lifetime history, and data on the worker's security clearance and radiation training record.

The ANS has issued one standard which directly addresses decommissioning. Approved by the American National Standards Institute, this is ANSI/ANS-15.10-1981, "Decommissioning of Research Reactors" [ANSI 1981]. The document includes discussion of such aspects as decommissioning alternatives, planning, surveillance, environmental assessment, quality assurance, and reporting and documentation. It recommends that plans for decommissioning should be included in the design stage for new facilities and, for existing operating reactors, in the design of major facility modifications. Items to be considered include occupational exposure, decontamination, work procedures, maintenance and surveillance and financial planning. On the subject of unrestricted use criteria, acceptable surface contamination levels are identical with those given in Regulatory Guide 1.86. The document points out that no unrestricted use criteria have been established for neutron-activated materials and that these are to be determined on a case basis by the cognizant regulatory authority.

The HPS Standards Committee was instrumental in developing the first surface contamination limits for materials and facilities to be released for unrestricted use [Wynveen 1985]. A proposed draft of ANSI N328 was completed in 1974 but never formally issued. Subsequently, the HPS Committee adapted N328 into several drafts and proposals of ANSI N13.12. As mentioned above, the limits contained in the proposed draft of ANSI N328 found their way into the NRC Regulatory Guide 1.86. Tabulations of the surface contamination limits proposed at various times can be found in [Wynveen 1985].

4. INTERNATIONAL STANDARDS AND GUIDELINES

The central international body for atomic energy-related matters, the International Atomic Energy Agency (IAEA), has issued many documents related to the D&D of nuclear facilities. Most of the publications serve to provide overviews of the various aspects and activities associated with D&D, based on the ideas, experiences and developments in the Member States and in other international organizations. Some, of more interest in the context of the present report, present draft codes and guidelines which can serve as bases for the development of rules and regulations by individual nations and groups of nations. It should be emphasized, however, the authority to impose such rules and regulations concerning D&D operations in a particular State rests ultimately with the Government in that State. The rules and regulations implemented by various national governments are treated in later separate sections of the present report.

An overview of the IAEA's work in the development of standards and regulations, and other aspects, of decommissioning can be found in [Feraday 1986] and [De 1991]. Also, the Nuclear Energy Agency of the Organization for Economic Cooperation and Development (NEA/OECD) has in place a cooperative program on decommissioning of nuclear installations, one of whose objectives is to promote cooperation between its member countries on the safety and regulatory aspects of nuclear development, including decommissioning [Bertini 1986; Jones, 1993]. Stevens et al. [Stevens 1992], discussing the prospective needs for decommissioning commercial nuclear facilities, highlight the need for basic criteria governing the release of materials from regulatory control and the long-term safety requirements for the final disposal of wastes.

The basic general publication with regards to D&D is Safety Series (SS) No. 52, Factors Relevant to the Decommissioning of Land-Based Nuclear Reactor Plants [IAEA 1980]. This document contains information on procedures, techniques and criteria covering all aspects of the process and is intended to provide assistance to those planning or implementing a decommissioning action. Topics addressed include the basic stages of decommissioning, decommissioning plans, the radiation protection program, and the criteria for the release of materials, facility or site. With respect to the last-named, the publication offers no quantitative guidance, deferring such matters to the "appropriate regulatory bodies."

Another publication in the Safety Series, No. 105, is titled "The Regulatory Process for the Decommissioning of Nuclear Facilities" [IAEA 1990]. The objective in this case is to provide general guidance for the regulation of decommissioning of nuclear facilities within established regulatory frameworks. It states that decommissioning regulations should "provide for the safety and radiological protection of the public and workers" and "reduce environmental impacts to acceptable levels." It requires that the recommendations of the ICRP [ICRP 1977] and the IAEA [IAEA 1982] concerning the basic principles of radiation protection be adopted during decommissioning. It also points out that large amounts of waste, both radioactive and nonradioactive, will probably be created and consideration should be given to methods of controlling this and later disposing of it. The publication devotes separate sections to such items

as planning for decommissioning, its facilitation, cost estimates and funding sources, and the responsibilities and functions of the various parties involved.

A follow-up report to Safety Series No. 105, but not part of the Safety Series of documents, is the technical document "National Policies and Regulations for Decommissioning Nuclear Facilities" [IAEA 1993]. This latest report provides an overview of the decommissioning policies and regulatory frameworks of various nations with nuclear facilities (notable exceptions are Russia and the newly independent states of the former Soviet Union, and the People's Republic of China). The report discusses the legal and regulatory frameworks adopted by the Member States of the IAEA, their policies and strategies with regard to decommissioning, waste management (including recycling and reuse of materials), financial assurance provisions and miscellaneous other aspects. Appendix 1 of the report provides examples of the decommissioning policies and regulations in some of the Member States while Appendix 2 condenses much of the information into a Decommissioning Database.

SS No. 74, "Safety in Decommissioning of Research Reactors," [IAEA 1986b] supplements the Code of Practice on the Safe Operation of Research Reactors and Critical Assemblies (Safety Series No. 35) and provides guidance on how to meet the safety requirements on decommissioning contained therein. Among the items covered are the sequencing of decommissioning activities, the contents of the decommissioning plan, the safety evaluation and the actual decommissioning process. The last of these includes subsections on fuel removal, decontamination, dismantling, radiation protection and waste management. The publication notes that the requirements of any national radiation protection and waste management regulations must be met or, if such have not been formulated, international recommendations may be followed.

Decommissioning of mines, mills and associated waste management facilities is addressed in SS No. 85, "Safe Management of Wastes from the Mining and Milling of Uranium and Thorium Ores: Code of Practice and Guide to the Code" [IAEA 1987b]. The Code of Practice contained in this publication is regarded as mandatory for the IAEA's own operations and for operations to which the Agency provides assistance. Guidance relevant to specific decommissioning requirements is found in Section 11 of the Code, including information on the status in several Member States (U.S.A., Canada, Australia and France).

The immediately preceding paragraphs discuss "Safety Series" publications that address the specific needs of decommissioning projects. Other publications in the Series treat safety in a more general context but nonetheless contain information of relevance to decommissioning. These include SS Nos. 6 ("Regulations for the Safe Transport of Radioactive Material"), 9 ("Basic Safety Standards for Radiation Protection") and 89 ("Principles for the Exemption of Radioactive Sources and Practices from Regulatory Control").

In addition to the "Safety Series" publications, the IAEA publishes information in a "Technical Reports Series" (TRS). As the title implies, this series of documents is directed more towards the technical aspects of nuclear-related problems. For example, in the case of

decommissioning, information is provided more in the form of how to accomplish the actual act, rather than what activities need to be considered and what criteria should be met. Nevertheless, the documents often contain mention and reference to the latter requirements.

TRS No. 267, "Methodology and Technology of Decommissioning Nuclear Facilities," [IAEA 1986a] discusses briefly the basic stages of decommissioning and the considerations which affect the selection of a decommissioning process for a particular nuclear facility in the initial part of the document. Later, the document addresses the need for national policies in decommissioning and reviews some of the criteria for release of equipment, materials and sites. It points out that, at that time (1986), no country had established regulatory limits which would allow unrestricted release of very low level radioactive waste. The release of such material is generally handled on a case by case basis, using ad hoc release criteria, the ranges of some values of which are given in the report.

TRS No. 278, "Methods for Reducing Occupational Exposures During the Decommissioning of Nuclear Facilities," [IAEA 1987a] provides little information on standards and regulations. It reiterates the three fundamental principles of the system of dose limitation proposed by the ICRP [ICRP 1977] and the IAEA [IAEA 1982], and discusses the technical and economic factors which need to be considered. However, the bulk of the document is given over to describing, as might be expected from the title, methods for reducing occupational exposures.

Similar comments apply to TRS No. 230, "Decommissioning of Nuclear Facilities: Decontamination, Dismantling and Waste Management" [IAEA 1983]. The first few pages describe in general terms considerations important to decommissioning but the subsequent sections address the methods by which decontamination, dismantling and waste management may be performed. An appendix ("annex") contains tables which summarize past decommissioning experiences and future plans in the Member States and there is also an extensive bibliography.

The specific topic of recycling or reuse of components from nuclear facilities is treated in TRS No. 293, "Factors Relevant to the Recycling or Reuse of Components Arising from the Decommissioning and Refurbishment of Nuclear Facilities" [IAEA 1988]. The matter of the availability of relevant radiological criteria is discussed in some detail and reference is made to the current practice of using ad hoc criteria based on existing legislation. Examples are given of the wide range of permissible levels of contamination which have consequently arisen. Other factors are also discussed but not in as much detail. Over half of the report is given over to an annex which deals with monitoring for compliance with the release criteria.

5. REGULATIONS IN BELGIUM

The regulations that pertain to decommissioning operations in Belgium have been summarized by Schrauben et al. [Schrauben 1992]. In effect, decommissioning operations are subject to all the laws and regulations that are applicable to the safe operation of nuclear installations, including guaranteed protection of workers, the public and the environment. The general framework for nuclear safety and radiological protection was established in a 1963 Royal Decree [IAEA 1993].

The law that treats with all aspects of decommissioning is that created in January 1991 that entrusts the supervision of decommissioning of all national installations to the National Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/NIRAS). The Agency itself was created in 1980 to manage radioactive waste and fissile materials, the 1991 decree serving to extend its mission to decommissioning activities [IAEA 1993]. This recent law deals with, among other aspects, the strategies, financing and operations associated with decommissioning, and with the transportation, processing, conditioning, storage and final disposal of the consequent wastes. The necessity for preparing and seeking approval of a decommissioning plan appears to be dependent of the type of facility involved. Operators of major facilities, such as nuclear power plants, must submit such plans and seek authorization to implement them as if they were starting up a new operation or facility. However, this does not seem to be the case for small or even intermediate size installations where radioactive materials are used for medical or industrial applications.

Protection of the workers and the population in general was addressed much earlier, in a royal decree issued in February 1963. This and other decrees were in the process of being revised at the time [Schrauben 1992] was presented. According to [IAEA 1993], this revision will extend the licensing requirements into the decommissioning field. The authorities have yet to define any regulations regarding the release of materials. Meanwhile, unrestricted and restricted releases have been approved on a case-by-case basis. For example, preliminary exemption values employed in the EUROCHEMIC decommissioning project were:

alpha surface contamination	-	max. 0.04 Bq/cm ²
beta/gamma surface contamination	-	max. 0.04 Bq/cm ²
total specific beta-gamma activity	-	max. 1 Bq/g.

6. REGULATIONS IN CANADA

A brief overview of the regulatory situation in Canada with regard to decommissioning can be found in [IAEA 1993]. The Canadian policy on the decommissioning of nuclear facilities is described in a Regulatory Policy Statement issued by the Atomic Energy Control Board (AECB) [AECB 1988]. The document itself represents a formal statement of the regulatory process and requirements applicable to the decommissioning of those facilities licensed and regulated by the AECB and is fairly general in nature. The AECB requires that a conceptual decommissioning plan be prepared while a new facility is in the initial design stage or, if a facility is already in operation, that such a plan be developed and submitted to the AECB. The plan should contain, among other items: estimates of the radiation levels and the quantity and types of radioactive substances present in the facility when operation is terminated; a description of the anticipated inventory of radioactive and toxic wastes arising from the decommissioning; a description of the measures taken to limit radiological and other hazards in the event of an accident; and an estimate of the residual radiation levels and the quantities and types of residual hazardous substances. The policy statement does not, however, go into specifics such as defining what are regarded as acceptable residual radiation levels. These are to be found in the individual Atomic Energy Control Regulations.

Paré [Paré 1992] presents the AECL's decommissioning philosophy, explains its foundations, describes its application to various facilities and summarizes the experience gained to date. In addition to other aspects, he emphasizes that the onus is placed on the owner of a facility to demonstrate the technical feasibility and the financial capability of decommissioning that facility. These and other aspects are also noted by Joubert et al. [Joubert 1992] in their discussion of the AECL's strategy for decommissioning Canadian nuclear facilities. The authors indicate that the priority given to decommissioning a nuclear facility is based on three considerations: the potential of the facility to be a continuing hazard, its age and present state, and the projected reuse of the land or facility. Joubert et al. also assert that the efforts to decommission Tunney's Pasture (a former radioactive isotope processing plant) for unrestricted public use should result in the establishment of "a policy and criteria for the final release of a once-nuclear site and for the segregation of radwaste below an agreed-upon "de minimis" level." The problem of radwaste disposal is, in itself, a separate concern when considering decommissioning. Both Joubert et al. and Gupta [Gupta 1992] point out that there is a lack of permanent disposal facilities in Canada for any commercially-produced radioactive waste, whether it be low level, medium level or high level.

More detail on decommissioning regulations can be found in [Whitehead 1986]. The author summarizes the history of regulatory development surrounding the decommissioning of uranium mines and mills in Canada and provides a listing of the major relevant documents involved. He follows this with descriptions of the experiences at three mines in closing down their operations and, in an appendix, a summary of the conditions and requirements contained in the AECB approvals for decommissioning at all three mines. The report also contains two comprehensive tables. The first of these summarizes recent AECB regulatory initiatives of

relevance to the decommissioning of uranium mines. Table 2 in that report lists the various decommissioning/reclamation activities involved and the associated requirements and criteria.

7. REGULATIONS IN THE CZECH AND SLOVAK REPUBLICS

The recent political changes that resulted in the breakup of the former Czechoslovakia into two republics have meant that new regulations are continually being drawn up to address the specific concerns of the individual countries. Whereas nuclear facilities were once under the jurisdiction of a centralized body, the responsibility for their safety and operation is now distributed among several governmental bodies representing the new republics and local administrations [Kučerka 1992] [IAEA 1993]. There are currently four nuclear power plants in operation in each of the republics and six others under construction (two in the Czech Republic and four in the Slovak Republic). One early power plant, NPP A-1 in Bohunice (Slovak Republic) is in the process of being decommissioned, having been shut down following an accident. There were few regulations in force at the beginning of the decommissioning activities so it has proceeded on a step-by-step basis, using existing regulations and operational provisions. A discussion of the chronological developments in the process can be found in [Kučerka 1992], together with a listing of the regulations concerning nuclear energy application. No details are provided of the regulations in force or of those proposed.

8. REGULATIONS IN FINLAND

There are four nuclear power plants in operation in Finland plus a research reactor. Overall, the nuclear activities at these facilities are regulated by the Nuclear Energy Act (renewed in 1988) and the Radiation Protection Act (renewed in 1992). Currently, the only requirement in effect relevant to decommissioning is that all have in place a decommissioning plan, even though the plants are likely to remain in operation well into the 21st century [Ryhänen 1992] [IAEA 1993]. These documents are intended to show that appropriate financial provisions have been made and that safe decommissioning is feasible. Further, these plans must be updated every five years, to reflect any changes that might occur in the interim. However, apart from this aspect, the Finnish authorities have yet to issue any specific regulations for decommissioning, thus forcing assumptions to be made when preparing or modifying the plans. For example, it is being assumed that the exemption limit will be 10 Bq/g.

9. REGULATIONS IN FRANCE

Hubert et al. [Hubert 1983] present a review of the problems facing decommissioning in many countries, including France, during the early nineteen eighties. The aspects which they treat in most detail are administrative procedures, the financing of decommissioning, the areas of responsibility during and after the operation, and the associated role of insurance.

A discussion of the regulatory aspects concerning decommissioning of nuclear installations in France is given in [Habib 1984]. Habib indicates that, at that time, the French did not have in place any special rules or regulations concerning D&D and goes on to discuss the application of the general regulations to this particular case. He lists the types of facilities which are defined as "nuclear" and describes the radioactivity limits in force at these installations. The author also addresses how the regulations are interpreted in practice and the fiscal aspects of D&D.

Some aspects of the French policy and regulations with regard to decommissioning have been discussed by Cregut, in [Cregut 1986]. Few specific details are provided but the author states that "regulatory measures taken for safety and protection continue beyond the period of operation and cease only after the radioactivity of each installation has reached an acceptable level." In addition, the regulatory authorities require "a technical file describing the state of the installation following final shutdown and the temporary or final states desired." This file would appear to be the equivalent to a safety analysis report, in that its contents should include description of the proposed methods of D&D, risk analyses, estimates of dose rates for workers and the public, and evidence of compliance with "all industrial safety regulations, the labor code, and all that encompasses nuclear safety and protection." Cregut emphasizes that, once the activities at a facility go beyond those originally authorized for its operation, new authorizations must be sought from several governmental bodies (for example, the Ministry for Industry, the Ministry for Health and the Ministry for the Environment). Decommissioning is an activity not generally included in the original authorization to operate a facility. Among the other points that the author makes is that "no policy on decommissioning can be separate from a waste management policy."

Little progress appears to have been made in producing D&D-specific regulations since Cregut's paper. Nokhamzon [Nokhamzon 1992], in discussing the decommissioning of nuclear facilities operated by the Commissariat à l'Energie Atomique (CEA), states that "dismantling operations are not covered by specific regulatory measures but are treated as a variant of the regulations applicable to nuclear facilities in general." One of the reasons given for this approach is that the nuclear power facilities are state-owned and operated, a condition "which ensures that they will not be tempted to evade their responsibilities during dismantling." However, that does not mean there is a carte blanche with regard to what can be done. The basic nuclear power legislation in France requires that construction or modification of a nuclear power facility (including dismantling) must be approved by a license signed by the prime minister. This license is only awarded after a technical safety evaluation has demonstrated that

the precautions taken will be sufficient to maintain an acceptably low risk for the personnel and the general public. [IAEA 1993] confirms the general lack of progress toward D&D-specific regulations.

Some information on regulations can be also gleaned from technical papers which describe decommissioning activities at individual facilities. For example, Roudil et al. [Roudil 1992] describe the D&D of a prototype vitrification facility at Marcoule. One of the requirements imposed on the operation involved compliance with the waste package specifications issued by French radioactive waste management agency (ANDRA). The paper notes what these are with regard to maximum permissible activity, maximum contact radiation level and maximum one-meter irradiation level.

10. REGULATIONS IN GERMANY

The legal and other regulatory requirements associated with decommissioning a nuclear facility in Germany are discussed in [IAEA 1993] and have been addressed in some detail in three fairly recent papers: Wolany et al. [Wolany 1992], Weil et al. [Weil 1992] and Brennecke et al. [Brennecke 1992]. The three papers have a co-author in common (Weil) and it is thus not surprising to find that there is much overlap of information. Weil was also coauthor of an earlier paper [Weil 1986] which dealt with decommissioning in the former Federal Republic of Germany. Consequently, for the purpose of summarizing their contents, it is appropriate to treat them as a single source.

According to Weil and his various co-authors, licensing procedures for decommissioning can be conducted on the basis of existing regulations but few of these are specific to decommissioning, per se. Thus regulations designed for the operational phase have to be applied and the authors cite the application of several sections of the Atomic Energy Act (AEA) and the Ordinance on Radiological Protection (ORP). For example, decommissioning, as well as the safe enclosure of a finally decommissioned installation or the dismantling of an installation or part of it, requires the issuance of a license. The purpose of the licensing procedure is to establish certain safety goals, including the prevention of unnecessary radiation, the keeping of all types of radiation exposure as low as practicable (even when values are below specified limits), and planning for the mitigation of the consequences of accidents or incidents. Although there is experience showing that the licensing procedure can be conducted on the basis of the existing regulations, experience has shown that interpretation of these regulations is not always straightforward when applied to D&D projects. Thus the authors assert that more specific rules are needed for several areas relative to decommissioning, such as incidents during decommissioning, the nuclide composition of radioactive effluents and the evaluation of decommissioning options. The authors also discuss the basic procedures and methods used in D&D operations, the radiation protection measures that must be taken, the need for release criteria, the recycling of scrap and aspects of decommissioning wastes. Other information contained in the three papers include data on the collective dose received by decommissioning workers from different decommissioning projects, from which it is concluded that decommissioning doses are normally less than the typical average collective dose received per annum during light water reactor operation. A tabulation is provided of the fifteen nuclear power plants currently shut down and to be (or being) decommissioned. [Wolany 1992] presents, in addition, a summary diagram showing the participants in the licensing procedure, their various responsibilities and how they interact.

[Hohenhinnebusch 1992] provides a list of 27 decommissioning projects, encompassing the 15 power plants identified by Weil and his co-authors and numerous processing facilities. The paper confirms that decommissioning is based on the AEA (particularly, Article 7.3) together with the ORP and the Atomic Procedural Provisions and that no specific rules exist pertaining to decommissioning. Article 7.3 of the AEA is invoked as soon as a nuclear facility is shutdown and "irreversible modifications of the system are planned, as a result of which a new start-up can be excluded." Compliance with the regulations is monitored by experts

appointed by the ministry in charge (e.g., the Technical Control Board and the State Institute for Environmental Protection). The authors state that "the permit is granted above all on the basis of the safety report, the very detailed supplementary documents, extensive plans, the dismantling manual, all radiation protection and working instructions, and the safeguards report."

The technical aspects of decommissioning three power reactors are discussed in [Miller 1987]. However, the paper also indicates some of the requirements that had to be met. These include the radioactivity levels permitted in metals to be reused or recycled and the release limit for surface contamination.

11. REGULATIONS IN ITALY

Italy had no specific decommissioning regulations in 1985 although revision of the basic law governing nuclear activities would include special consideration of this activity [Laraia 1986]. Until such laws were enacted, decommissioning was being treated as just one more stage (or sequence of stages) of the normal operation of a nuclear plant and subject to the same regulatory process as other stages. Requests for a decommissioning license would have to be accompanied by a safety report that covered such items as radiological characterization of the plant, safety and radiation protection measures associated with the planned activities and the final plant condition on completion of the decommissioning. Laraia continues by discussing what actions had been taken in respect of the decommissioning of three research reactors (Ispra-1, ROSPO and RITMO) and some issues that needed resolution. Among the latter was the need to establish clear levels of acceptable residual radioactive concentration/contamination for unrestricted use of materials, structures and sites.

Several years later, although there are now ten nuclear installations in Italy in the process of being decommissioned, such activities remain essentially under the basic law governing nuclear activities [IAEA 1993]. Some regulatory issues have been resolved but most remain to be decided [Laraia 1992]. However, exemption limits have been adopted to differentiate radioactive from nonradioactive material. These limits are: for beta-gamma emitters, 1 Bq/g (solid substances) and 1 Bq/cm² (surface contamination); for alpha emitters, 0.1 Bq/g (solid substances) and 0.1 Bq/cm² (surface contamination). The threshold dose rate for nonradioactive materials has been set at 0.1 μ Sv/h.

D'Anna and Di Renzo, in [D'Anna 1993], discuss the Italian strategy for decommissioning nuclear power plants, with particular attention to the Latina and Garigliano plants. The authors point out that the lack of specific regulations concerning decommissioning and the absence of a final repository for radioactive waste has severely hampered the planning process. Nonetheless, both plants will be put in a "passive safe enclosure" (CPP) state where they will remain, possibly for several decades, until final dismantling is begun. The paper deals mainly with the various aspects of bringing the plants to the CPP state, including radioactive inventory estimates and waste processing plans.

12. REGULATIONS IN JAPAN

The decommissioning of nuclear facilities has only recently been initiated in Japan but a comprehensive program to develop the technology and regulations which will be needed is already underway [Komatsu 1993]. According to Komatsu, the policies are determined by the Japan Atomic Energy Commission (JAEC) and implemented by the Science and Technology Agency and the Ministry of International Trade and Industry. The JAEC's long-term program with regard to decommissioning of power plants states that, "in principle, a reactor should be dismantled after termination of its operation and the site should be efficiently re-used for the next generation of nuclear power stations." A non-profit organization, the Research Association for Nuclear Facility Decommissioning (RANDEC), is working on "related legislation and regulations such as licensing procedures for reactor decommissioning, certification of site-release criteria and waste management issues." A key point in the Japanese program is that nuclear power plants should be decommissioned to "Stage 3" (sometimes called the "green field" level) [Hoshi 1992; Yokota 1992].

The Japanese are currently in the process of dismantling the Japan Power Demonstration Reactor and analyzing the data obtained during the various activities. The Japan Nuclear Safety Commission published a report entitled "Philosophy of Safety Assurance during Reactor Dismantlement - Dismantling JPDR" early in the project (1985) but little information is available of the contents of this report. According to Yokota and Yanagihara [Yokota 1993], it states the guidelines necessary to ensure safety during the dismantling and formed the basis for the subsequent "enforcement plan." "The key principles of the enforcement plan are to ensure the safety of the workers and to prevent radioactive materials from being released." [Yokota 1993] provides some details on the organization of the program, radiation protection control and waste management. Additional information on the "Philosophy" document is found in [IAEA 1993], where it is stated that it "includes requirements and recommendations on:

- actions to be taken to ensure that the reactor remains shutdown;
- maintenance of the facilities during decommissioning;
- reduction of radiation exposure to the public and workers;
- treatment of radioactive waste;
- demonstration of completion; and
- safety evaluation."

13. REGULATIONS IN RUSSIA AND THE NEWLY INDEPENDENT STATES OF THE FORMER SOVIET UNION

The decommissioning of nuclear installations in the Russian Federation and the newly independent states of the former Soviet Union has been under consideration since at least 1984 [Kremnev 1990]. At that time, a collaborative venture involving Bulgarian, Czechoslovakian and Soviet specialists was initiated to develop a concept of decommissioning nuclear power plants. The program was completed in 1989 but few details are available, other than that it "addresses criteria for ensuring safety, ecological, economic, socioeconomic and health questions," among other items. A recent paper by Kremnev and Gavrilov [Kremnev 1993] provides some more detailed information of the decommissioning of nuclear installations in the Russian Federation and the newly independent states of the former Soviet Union.

14. REGULATIONS IN SWEDEN

There are currently twelve nuclear power reactors operating in Sweden, none of which, by government decree, shall be operated beyond the year 2010 [Pettersson 1994]. In addition, there are several research reactors and associated laboratories which are in the process of being decommissioned [Devell 1986]. However, there is currently no specific policy regarding decommissioning and activities to date have been regulated on a case-by-case basis [IAEA 1993]. There is no explicit requirement that decommissioning activities, per se, be licensed but in reality they are reviewed by virtue of the fact that they involve changes in construction and operation of a facility. There is also a requirement that "research plans" be submitted for nuclear reactors, "to ensure that decommissioning can be performed in an appropriate way when needed." No such plan is necessary for other types of nuclear facilities.

Wilhelmsson and Larson [Wilhelmsson 1980] describe the situation in Sweden in 1980, at which point in time a referendum was about to be held to determine the future of nuclear power in the country. The authors describe briefly the two laws which govern nuclear energy work in Sweden and indicate that they are not well suited to dealing with decommissioning of nuclear facilities. Thus, irrespective of the outcome of the referendum, new legislation was needed in this area.

Hubert et al. [Hubert 1983] present a review of the problems facing decommissioning in many countries, including Sweden, during the early nineteen eighties. The aspects which they treat in most detail are administrative procedures, the financing of decommissioning, the areas of responsibility during and after the operation, and the associated role of insurance.

[Pettersson 1994] indicates that licensing applications will be needed before decommissioning can begin but provides no information on what specific criteria may be applied. The authors state that in studies of process systems a limit of 1 Bq/g is being used to designate whether a material is radioactive or nonradioactive. They then point out that analyses are being conducted to determine how different free release levels affect the amount of waste produced, inferring that this particular criterion has not yet been fixed. On the other hand, Andersson et al. [Andersson 1994] treats 1 Bq/g as at least a goal residual activity level for decontaminated scrap.

15. REGULATIONS IN THE UNITED KINGDOM

The United Kingdom (UK) has a well-developed process for the decommissioning of nuclear facilities, much of which is adequately summarized in [IAEA 1993]. Gardner and Rae [Gardner 1992] give a brief overview of the regulation of decommissioning commercial nuclear power stations in practice in the United Kingdom (UK) while Ross [Ross 1990] addresses the regulatory aspects from a slightly different perspective. The latter includes discussion of the safety policy and assessments of the Nuclear Installations Inspectorate (NII), the IAEA decommissioning criteria and the implications of Article 37 of the European Treaty. Though neither article provides examples of specific quantitative guidance with regard to such matters as radiological protection, Ross cites the development by the NII of a framework which can be used in safety assessments. This is entitled "Safety Assessment Principles for Nuclear Power Reactors," a document originally produced in 1979 and subsequently amended in 1988. Ross further points out that the NII "does not issue standards or codes of practice for nuclear plants. Rather, it expects each licensee to develop his own safety design criteria and requirements. These criteria are not formally approved or promulgated as standards or codes, though they may very well make reference to national and international criteria."

Recently, the NII issued a revised combined version of the earlier documents, entitled "Safety Assessment Principles for Nuclear Plants" [NII 1992]. This covers every aspect of a nuclear plant, up to and including decommissioning. Numerical principles are given regarding dose limits and objectives for both the plant workers and the general public, complete with explanatory notes on how the limits had been derived. The document also recommends the performance of probabilistic safety analyses and provides guidance regarding predicted accident frequencies and associated maximum effective doses to offsite persons. However, the decommissioning-specific guidance is very limited and is directed towards the design of new plants. It states, in part, that "the licensee should prepare an outline decommissioning plan which shows that the design of the plant will facilitate its safe decommissioning and dismantling."

In practice, a phased and progressive approach to decommissioning has been adopted in the U.K. Colquhoun et al. [Colquhoun 1994] indicate that an integral part of this approach is the preparation of safety documentation. "Depending on the complexity of the decommissioning there may be one or several documents produced that need to satisfy the regulatory requirements under which operating work is undertaken." Typically, an overall safety document is prepared initially, identifying the main safety issues and the measures that might possibly be taken. After this has been approved, "a more detailed safety case is then developed prior to each of the main phases of decommissioning." Thus, in the U.K., it is not normal to develop fully the safety issues for the whole project before actual work commences.

Flowers et al. [Flowers 1992] provide insight to some of the regulations in effect with respect to waste arisings and their importance in determining decommissioning strategy. The authors supply, among other details, the definitions of the various waste classifications and indicate the disposal options, including what may be buried at a conventional landfill site.

In a different vein, Neale [Neale 1992] provides a useful insight of the way in which directives issued by the European Economic Community (EEC) are transformed into UK legislation. Directives are arrived at following extensive discussion and debate, have to be approved at a meeting of the Council of Ministers and, ultimately, passed by the European Parliament. To quote Neale, "a directive is a legal device used by the EEC to establish policy. The Directive has to be implemented by the individual member states. Usually this involves domestic legislation although some measures may be dealt with by administrative arrangements. The European Commission checks that the Directive has been properly implemented." Neale then describes how directives are prepared and the procedures involved in adopting and implementing them. With respect to the U.K., directives that will affect the health and safety aspects of decommissioning were in preparation in 1992 but legislation had not been enacted. Neale goes on to discuss in some detail the safety and health requirements as they have emanated from the Directives and how they might affect decommissioning projects. The information as presented covers the many aspects involved in health and safety concerns in general and emphasizes the importance of risk assessments in the overall process. It does not, however, address the problems which might be specifically associated with the decontamination and decommissioning of nuclear installations.

16. REGULATIONS IN OTHER COUNTRIES

Decommissioning work has started relatively recently in the People's Republic of China and the development of appropriate codes, regulations and criteria is still in progress [Dong 1992]. Advantage is being taken of the groundwork done in these areas by the IAEA and countries such as the USA, Canada and France. The approaches being adopted include dividing the facility under consideration into zones based on the level of radioactivity present and adopting the ALARA principle of dose limitation recommended by the ICRP.

There is limited nuclear activity in Egypt and Thailand but plans are underway to decommission each country's first research reactor. Regulatory guides and exemption levels are to be prepared before any major decommissioning activities begin in Egypt [Elkady 1994]. In Thailand, according to [Yamkate 1994], the Office of Atomic Energy for Peace is responsible for regulatory controls and is to establish decommissioning regulations based on the IAEA's 1990 Safety Series 105 [IAEA 1990]. These are expected to be completed in 1995.

Spain has numerous nuclear facilities currently being (or about to be) decommissioned, including a commercial power plant (Valdellós I), several research reactors and the uranium mill at Andujar [Gravalos 1992]. However, little information has been found concerning the regulations imposed on these projects. There appear to be few decommissioning-specific regulations, this particular phase being regarded as part of a plant's life cycle and subject to the existing regulatory framework [IAEA 1993]. However, an order was issued by the Ministry of Industry concerning the selection of decommissioning alternatives for Valdellós I. One of the significant issues of the moment is the development of an exemption policy and the associated criteria and methodologies.

According to [IAEA 1993], India has yet to adopt a specific policy on decommissioning, choosing instead to consider it as an extended phase of the operating life of a facility. Two research reactors plus the process cells of a fuel reprocessing plant have already been decommissioned, these activities being performed in accordance with approved decommissioning plans.

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